Land Use Policy Group

The GB statutory conservation, countryside and environment agencies

The Integration of Agricultural, Forestry and Biodiversity Conservation Policies with Flood Management in England and Wales

Liesbeth van Kampen-Brouwer/Dr Helen Stark/Lucy Bazeley
Fola Ogunyoye (Posford Haskoning Ltd)
Paul Withers (Agricultural Development and Advisory Service)
John Firn (Firn Crichton Roberts)
Guy Watt (John Clegg Consulting)

11 June 2004

ENGLISH NATURE
The Countryside Agency
Cyngor Cefn Gwlad Cymru Countryside Council for Wales
Environment Agency
Scottish Natural Heritage
Joint Nature Conservation Committee

A COMPANY OF

ROYAL HASKONING

POSFORD HASKONING LTD
ENVIRONMENT

Rightwell House
Bretton
Peterborough PE3 8DW
United Kingdom
+44 (0)1733 334455 Telephone
01733 333348 Fax
info@peterborough.royalhaskoning.com E-mail
www.royalhaskoning.com Internet

Status	Final Report
Date	11 June 2004
Project name	The Integration of Agricultural, Forestry and Biodiversity Conservation Policies with Flood Management in England and Wales
Project number	9M5747/02/34A/R001/LvK/HS/Pb
Author(s)	Liesbeth van Kampen-Brouwer/Dr Helen Stark/Lucy Bazeley/Fola Ogunyoye/Paul Withers/John Firn/Guy Watt
Client	Countryside Council for Wales
Reference	9M5747/02/34A/R001/LvK/HS/Pb

Drafted by	Liesbeth van Kampen-Brouwer/Dr Helen Stark/ Lucy Bazeley/Fola Ogunyoye/Paul Withers/John Firn/Guy Watt
Checked by	Dr Helen Stark
Date/initials check	……. …….
Approved by	Lucy Bazeley, Director Land and Water Advice Group
Date/initials approval	……. …….

The Land Use Policy Group
The Land Use Policy Group (LUPG) of the GB statutory conservation, countryside and environment agencies comprises the Countryside Agency, Countryside Council for Wales, English Nature, Environment Agency, Joint Nature Conservation Committee and Scottish Natural Heritage.

The LUPG aims to advise on policy matters of common concern related to agriculture, woodlands and other rural land uses. It seeks to improve understanding of the pros and cons of policy mechanisms related to land use, particularly farming and forestry; to develop a common view of desirable reforms to existing policies; and to promote these views.

The Countryside Agency
The Countryside Agency (CA) is the statutory body working to make life better for people in the English countryside and to improve the quality of the countryside for everyone. It is working to achieve: empowered, active and inclusive communities; high standards of rural services; vibrant local economies; all countryside managed sustainably; recreation infrastructure that's easy to enjoy; and, a vibrant and diverse urban fringe providing better quality of life. The CA's role is: statutory champion and watchdog; influencing and inspiring solutions through its 'know how' and 'show how'; and delivering where it is best placed to add value. http://www.countryside.gov.uk

Countryside Council for Wales
Countryside Council for Wales (CCW) is the Government's statutory adviser on sustaining natural beauty, wildlife and the opportunities for outdoor enjoyment throughout Wales and its inshore waters. With English Nature and Scottish Natural Heritage, CCW delivers its statutory responsibilities for Great Britain as a whole, and internationally, through the Joint Nature Conservation Committee.
http://www.ccw.gov.uk

English Nature
English Nature (EN) is the Government Agency that champions the conservation of wildlife and geology throughout England. It does this by: advising Government, other agencies, communities and individuals; regulating activities affecting the special nature conservation sites in England; helping others to manage land for nature conservation and advocating nature conservation for all and biodiversity as a key test of sustainable development. http://www.english-nature.org.uk

Scottish Natural Heritage
Scottish Natural Heritage (SNH) is a government body established to secure conservation and enhancement of Scotland's unique and valued natural heritage – the wildlife, habitats and landscapes that have evolved in Scotland through long partnership between people and nature. SNH advises on policies and promotes projects that aim to improve the natural heritage and support its sustainable use. Our aim is to help people to enjoy Scotland's natural heritage responsibly, understand it more fully and use it wisely so it can be sustained for future generations. http://www.snh.org.uk

The Environment Agency
The Environment Agency (EA) is the leading public organisation for protecting and improving the environment in England and Wales. We achieve this by regulating industry, maintaining flood defences and water resources, and improving wildlife habitats, in addition to our many other activities. We also monitor the environment, and make the information that we collect widely available. http://www.environment-agency.gov.uk

Joint Nature Conservation Committee
The Joint Nature Conservation Committee (JNCC) is the forum through which the three country conservation agencies – CCW, EN and SNH - deliver their statutory responsibilities for Great Britain as a whole, and internationally. These responsibilities contribute to sustaining and enriching biological diversity, enhancing geological features and sustaining natural systems. As well as a source of advice and knowledge for the public, JNCC is the Government's wildlife adviser, providing guidance on the development of policies for, or affecting, nature conservation in GB or internationally. http://www.jncc.gov.uk

Disclaimer
This report was produced by the authors on behalf of the Land Use Policy Group (LUPG). The views expressed within the report are those of the contractors and do not necessarily reflect the views of the agencies within LUPG.

To Contact the LUPG:

Address:
LUPG Support Officer
JNCC Monkstone House
City Road
Peterborough
PE1 1JY

Email: lupg@JNCC.gov.uk

Website: www.lupg.org.uk

CRYNODEB GWEITHREDOL

Cyflwyniad a'r Prif Ganlyniadau

Nid ffenomenon diweddar yw llifogydd, ac maent wedi achosi difrod difrifol a cholli bywydau ers dechrau cadw cofnodion. Fodd bynnag, er gwaetha'r hanes hir a buddsoddi sylweddol dros flynyddoedd lawer mewn amddiffynfeydd rhag llifogydd, awgryma profiad y blynyddoedd diwethaf fod amlder llifogydd a'r effeithiau y byddant yn eu hachosi ar gynnydd.

Cymdeithas ei hun, yn rhannol, fan leiaf, sydd wedi creu'r sefyllfa barhaus hon, sy'n gwaethygu'n lleol, yn rhanbarthol, yn genedlaethol ac yn fyd-eang, Mae dulliau anghynaliadwy wedi'u mabwysiadu i reoli'r tir, rheoli afonydd a datblygu gorlifdiroedd ac ardaloedd sydd mewn perygl o lifogydd. Bydd newidiadau mewn glawiad a lefel y môr a achosir gan newid yn yr hinsawdd yn cynyddu ymhellach y perygl o lifogydd mewn afonydd ac ar yr arfordir. Gall yr ardaloedd hynny sydd mewn perygl ar hyn o bryd fod y rhai sy'n cael eu heffeithio fwyaf, er y gall ardaloedd newydd hefyd gael eu heffeithio.

Er y gall fod yn fuddiol i barhau i fuddsoddi mewn mesurau amddiffyn digonol rhag llifogydd yn y tymor-byr, mae'r astudiaeth hon yn archwilio'r cyfraniad tymor-canolig i dymor-hir y gall newidiadau o ran rheoli'r tir eu gwneud i reoli llifogydd, a hynny'n gynaliadwy. Yn gyntaf edrychir ar y dystiolaeth bresennol y gall newidiadau i ddefnyddio a rheoli tir mewn ardaloedd gwledig gael dylanwad ar ddŵr ffo a chreu llifogydd. Gan ddefnyddio canlyniadau'r adolygiad i'r dystiolaeth i ganolbwyntio ar y llifogydd sy'n digwydd sydd debycaf o gael eu dylanwadu gan reoli'r tir, asesir wedyn y potensial i integreiddio'r polisi, fframweithiau cyllidebol a rheoleiddiol sy'n llywio rheoli tir gwledig, â'r rheini sy'n llywio rheoli llifogydd. Mae'r adran hon yn canolbwyntio ar y mathau hynny o weithgareddau rheoli sydd â'r potensial mwyaf i effeithio ar ddŵr ffo.

O'r llenyddiaeth bresennol, mae'n amlwg, tra nad yw effeithiau newidiadau o ran defnyddio a rheoli'r tir ar greu dŵr ffo eto wedi'u sefydlu'n glir, mae newidiadau sylweddol a mesuradwy o ran creu dŵr ffo mewn caeau unigol wedi'u hadnabod. Fodd bynnag, ceir llawer llai o dystiolaeth i awgrymu bod newidiadau mewn dŵr ffo a draeniad a achosir gan reoli tir, yn cael eu trosglwyddo i'r system ddŵr wyneb gan effeithio ar raddfa'r dalgylch. Yn rhannol, ceir diffyg tystiolaeth oherwydd nad oes ond ychydig astudiaethau wedi'u cynnal i brofi hyn. Yn ychwanegol, nid oes fawr o astudiaethau wedi'u cynnal gyda'r nodau arbennig hyn.(O'Connel *et al*., 2003).

Mae angen gwneud rhagor o ymchwil drylwyr i archwilio effeithiau rheoli tir gwledig ar greu llifogydd ar raddfa fawr, ac, yn wir, mae ymchwil o'r fath yn yr arfaeth ar hyn o bryd. Yn gyffredinol, cydnabyddir bod angen astudiaethau dalgylch ar raddfa fwy i ategu patrymau creu llifogydd newydd, sy'n gallu rhoi ystyriaeth lawn i reoli a defnyddio'r tir. Fodd bynnag, ceir tystiolaeth fod effaith rheoli tir gwledig ar y perygl o lifogydd yn sylweddol mewn achosion o lawiad llai. Tra disgwylir yn gyffredinol y bydd yr effaith hon, a ddaw'n sgil rheoli tir, ar y perygl o lifogydd yn mynd yn llai wrth i'r lifogydd sy'n digwydd droi'n ddigwyddiadau eithafol, mae'n debyg bod cyfleoedd i leihau amlder ac effaith glawiad ar y llifogydd canolig sy'n digwydd, drwy newid neu addasu rhai agweddau ar reoli tir gwledig.

Mae'r astudiaeth wedi canfod bod cyfleoedd sylweddol i integreiddio'r fframweithiau polisi, cyllidebol a rheoleiddiol, i weithredu'n well ar gyfer rheoli tir gwledig a rheoli

llifogydd, a allai, pe baent yn cael eu gweithredu, gyfrannu at leihau amlder ac effaith y llifogydd sy'n digwydd ar raddfa fach i ganolig. Hefyd, gallai'r fframweithiau integreiddiedig hyn ddod â manteision lluosog i'r economi leol a bioamrywiaeth.

Mae'r prif argymhellion yn cynnwys:

- Parhau i ddatblygu cynlluniau amaeth-amgylcheddol i hyrwyddo mesurau rheoli tir sy'n lleihau creu dŵr ffo a draeniad ac felly sy'n cyfrannu at leihau llifogydd a gwasgaru llygredd;
- Rheoliadau newydd i reoli draenio tir er mwyn rheoli llifogydd a bioamrywiaeth;
- Defnyddio cyllid bloc ar gyfer amddiffynfeydd llifogydd, i ariannu gweithgareddau a newidiadau rheoli tir unigryw neu barhaus;
- Gwell gwybodaeth a hyfforddiant i reolwyr tir ar sut i reoli'r tir a'r pridd er mwyn lleihau dŵr ffo;
- Cysylltiad gwell rhwng proses cynllunio rheoli llifogydd y dalgylch a mecanweithiau cynllunio a chyllidebol gwledig, er enghraifft strategaethau coedwigaeth cenedlaethol;
- Creu 'timau dalgylch' sydd ag aelodau o gyrff sy'n gyfrifol am reoli dŵr a thir, ond sydd â chyllideb unigol, i yrru cynllunio dalgylch integreiddiedig yn ei flaen;
- Datblygu cynlluniau gofodol gwledig i flaenoriaethu materion sy'n ymwneud â rheoli dŵr a llifogydd mewn rhai dalgylchoedd; a
- Gwell defnydd a defnydd cynyddol o'r Prif Ddangosyddion Perfformiad cymdeithasol wrth reoli llifogydd, a datblygu mwy o offer cost/budd strategol i gyfrifo'r manteision ehangach sydd gan wahanol ddulliau o reoli llifogydd.

Amcan a Nodau'r Astudiaeth

Prif amcan yr astudiaeth hon, a gynhyrchwyd gan y Grŵp Polisi Defnyddio Tir, oedd adnabod y potensial ar gyfer integreiddio polisïau cadwraeth amaethyddiaeth, coedwigaeth a bioamrywiaeth â rheoli llifogydd yng Nghymru a Lloegr. Yn ychwanegol at hyn, amlygwyd unrhyw orgyffwrdd â fframweithiau'r Alban wrth ddadansoddi faint o le oedd i integreiddio rhwng y meysydd polisi.

Amcanion penodol yr astudiaeth oedd:

- Disgrifio'r fframwaith rheoli llifogydd presennol yng Nghymru, Yr Alban a Lloegr (gan ganolbwyntio ar y trefniadau yng Nghymru a Lloegr);
- Disgrifio'r ffactorau rheoli tir gwledig sy'n dylanwadu ar y perygl o lifogydd a'u helaethrwydd;
- Adnabod a disgrifio'r mecanweithiau polisi, rheoleiddiol a rheoli cyllideb;
- Disgrifio'r cyrff perthnasol a'u swyddogaethau a'u cyfrifoldebau;

- Dadansoddi'r cyfle i integreiddio'r gwahanol feysydd polisi;

- Trefnu a chynnal seminar i gyflwyno canlyniadau'r astudiaeth i aelodau Grŵp Llywio'r Grŵp Polisi Defnyddio Tir a budd-ddeiliaid eraill.

Y Dull o Astudio

Y dull a fabwysiadwyd oedd adolygu'r agweddau canlynol drwy gyfuniad o adolygu llenyddiaeth ac ymgynghori:

- Y polisi rheoli llifogydd presennol, fframweithiau rheoleiddiol a chyllidebol;
- Gweithgareddau ac arferion defnyddio a rheoli tir sy'n gallu effeithio ar y perygl o lifogydd a'u helaethrwydd a'r amgylchedd (ac sy'n dangos yr addewid mwyaf o ran integreiddio polisi yn y dyfodol);
- Y pethau sy'n gyrru ac yn dylanwadu ar y gweithgareddau a'r arferion hyn; a
- Swyddogaeth a chyfrifoldebau pob un o'r prif actorion a rheolwyr yn y polisi presennol.

Ar ôl sicrhau'r ddealltwriaeth hon, ymgymerwyd â 'dadansoddiad bylchau' o'r polisi presennol er mwyn asesu:

- Pa mor dda y mae'n gweithio ar hyn o bryd;
- Sut ac os bydd angen ei addasu;
- A fydd datblygu strategol yn helpu wrth ymdrin â diffygion; a
- Pha bolisïau y gall fod eu hangen i lenwi'r bylchau a chyfrifoldebau amdanynt.

Gweithgareddau ac arferion Defnyddio a Rheoli Tir sy'n dylanwadu ar Greu Dŵr Ffo

Yn seiliedig ar y data sydd ar gael, yr arferion defnyddio tir sy'n cynyddu'r perygl o lifogydd a'u helaethrwydd yn fwyaf sylweddol ar gyfer pob maes polisi yw:

Amaethyddiaeth:
- Patrwm a graddfa gweithrediadau defnydd tir unigol;
- Draeniad tir sy'n dibynnu ar y math o bridd a'r drefn wlybaniaeth (tystiolaeth fesuradwy ar gael);
- Y symudiad oddi wrth amaethyddiaeth gymysg i systemau mwy arbenigol a'r gostyngiad o ganlyniad yn y sylwedd organig ar gyfer y fferm i roi maeth i'r pridd;
- Rheoli tir âr (megis gweithgarwch anamserol ar bridd sydd â'r duedd briodol), gan arwain at gywasgu'r pridd, capio pwdin a phantiau aredig (tystiolaeth fesuradwy ar gael);
- Tyfu cnydau 'peryglus' fel indrawn (tystiolaeth fesuradwy ar gael);
- Pori mewn rhai lleoliadau daearyddol arbennig ac o dan drefn reoli benodol gan arwain at gywasgu'r pridd (tystiolaeth fesuradwy ar gael); a
- Cholli systemau a nodweddion cadw dŵr ar ffermydd megis llynnoedd.

I raddau llai:

- Tynnu dŵr lle y ceir defnyddwyr dŵr masnachol mawrion.

Coedwigaeth:
Yr arferion hynny sy'n cael mân effeithiau yw:

- Symud coed (tystiolaeth fesuradwy ar gael);
- Cynhaeafu (effaith leoledig);
- Draeniad (effeithiau lleoledig, yn gostwng dros amser).

Cadwraeth Natur:
- Yr angen am lefelau trwythiad uchel mewn safleoedd penodedig (a all wrthdaro â rheoli llifogydd wrth i'r hyn a gedwir yn y pridd gael ei leihau).

Y Prif Gyfleoedd i Integreiddio (Polisi, Cyllidebol, Rheoleiddiol a Threfniadol)

Yn seiliedig ar ganlyniadau adolygu'r dystiolaeth, mae'r newidiadau tymor-byr/canolig a hir wedi'u hadnabod fel cyfleoedd ymarferol i gynyddu'r integreiddio rhwng polisi rheoli, polisi, cyllid rheoleiddio a threfnu tir gwledig, a rheoli llifogydd. Mae Adran 7 yn cynnwys amrywiaeth ehangach o argymhellion mwy penodol a manwl a fydd yn gymorth wrth realeiddio rhai o'r newidiadau hyn.

(Tymor byr i ganolig)

- Defnyddio'r cyfleoedd wrth ddiwygio'r Polisi Amaethyddol Cyffredinol yn llawn, yn enwedig drwy gysylltu'r camau penodol y gofynnir amdanynt â'r broses gynllunio rheoli llifogydd dalgylch a'r trefniadau newydd ar gyfer taliadau.

- Parhau i ddatblygu ymhellach o gynlluniau amaeth-amgylchedd i hyrwyddo a chyllido mesurau rheoli sy'n lleihau dŵr ffo ac erydiad y pridd ac sydd felly'n lleihau'r perygl o lifogydd a'u helaethrwydd.

- Gwell cysylltiad rhwng proses gynllunio rheoli llifogydd y dalgylch, cynllunio gwledig a mecanweithiau cyllidebol, er enghraifft, gyda strategaethau coedwigaeth cenedlaethol a chynlluniau datblygu gwledig.

- Hwyluso defnyddio cyllid bloc ar gyfer amddiffynfeydd llifogydd i ariannu gweithgareddau rheoli tir cyfalaf a newidiadau megis lliflinio cyllid i'w ddefnyddio wrth greu golchdir ac adfer gorlifdir.

- Darparu gwybodaeth a hyfforddiant i reolwyr tir ar fesurau ymarferol i leihau creu dŵr ffo ac felly gyfrannu at leihau llifogydd a llygredd gwasgaredig.

Adolygu canllawiau'r arferion rheoli gorau presennol ar:

- Reoli llifogydd;
- Creu ac adfer golchdir a gorlifdir;
- Rheoli'r pridd; a
- Chynllunio cylchfeydd torlannol a chlustogau draeniad mewn fforestydd

i sicrhau bod gweithgareddau rheoli tir/creu dŵr ffo'n cael eu hystyried.

- Defnyddio'r Prif Ddangosyddion Perfformiad amgylcheddol a chymdeithasol yn well ac yn fwy wrth reoli llifogydd a datblygu mwy o offer budd/cost strategol i gyfrifo manteision ehangach gwahanol ddulliau o reoli llifogydd.

(Tymor canolig i hir)

- Creu 'timau dalgylch' yn cynnwys aelodau o gyrff rheoli tir a dŵr, ond sy'n gweithredu o dan gyllideb unigol ar gyfer cydweithredu ac integreiddio ym mhob dalgylch.

- Datblygu 'cynlluniau gofodol' gwledig i flaenoriaethu materion dŵr a rheoli mewn rhai dalgylchoedd arbennig. Byddai'r rhain yn dod â manteision economaidd ac amgylcheddol ehangach yn ychwanegol at well rheolaeth o beryglon llifogydd a'u helaethrwydd.

- Rheoliadau newydd i reoli draenio tir ar gyfer rheoli llifogydd a bioamrywiaeth.

- Datblygu offeryn strategol i asesu'r perygl o lifogydd (gan gynnwys rheoli tir gwledig) i'w ddefnyddio wrth lunio canllawiau cynllunio (Arweiniad Polisi Cynllunio 25 a Nodyn Cyngor Technegol 15), a'i ddefnyddio ar gyfer newidiadau sylweddol o ran defnyddio tir ar y cyd ag Asesiad Effaith ar yr Amgylchedd.

EXECUTIVE SUMMARY

Introduction and Key Findings

Flooding is not a recent phenomenon and has caused severe damage and loss of life since records began. However, despite this long history, and significant investment over many years in flood defences, experience in recent years suggests that both the frequency of floods and the impacts they cause are increasing.

Such a continuing and worsening situation is, at least in part, of society's own making at local, regional, national and global scales. Unsustainable approaches have been adopted to land management, river management, and development in floodplains and flood risk areas. Changes in rainfall and sea level caused by climate change will further increase the risks of both river and coastal flooding. Those areas currently at risk will potentially be the most affected, although new areas may also be affected.

Whilst continued investment in adequate flood defence measures may be beneficial in the short-term, this study investigates the possible medium to long- term contribution that changes to land management may make to sustainable flood management. It first examines the existing evidence that changes to land use and land management in rural areas may influence run-off and flood generation. Using the findings of the evidence review to focus on flood events most likely to be influenced by land management, it then assesses the potential for integrating the policy, budgetary and regulatory frameworks that govern rural land management with those that govern flood management. This section concentrates on those types of management activities that have most potential impact on run-off.

From the existing literature, it is clear that whilst the impacts of land use and land management changes on run-off generation have not been clearly established, significant and quantifiable changes in run-off generation at the field-scale have been identified. There is however, much less evidence to suggest that land management-induced changes in run-off and drainage are transferred to the surface water system and have an impact at the catchment-scale. The lack of evidence is partly because few studies have been undertaken to test this. In addition, very few studies have been undertaken with these specific objectives (O'Connell *et al*., 2003).

More thorough research to investigate the impacts of rural land management on large-scale flood generation is needed, and is indeed currently planned. It is generally recognised that larger scale catchment studies are needed to underpin new flood generation models that are able to take land management and use fully into account. However, there is evidence that the effect of rural land management on flood risk is significant for smaller rainfall events. While it is generally expected that this land management effect on flood risk will reduce as events approach extreme events, it is likely that there is scope for reducing the frequency and impact of small to medium-scale flood events, by changing or modifying some aspects of rural land management.

The study finds that there are significant opportunities for better integration of the policy, budgetary and regulatory operational frameworks for rural land management and flood management that if implemented, could contribute to reducing the frequency and impact of small/medium- scale flood events. These integrated frameworks could also bring multiple benefits for the rural economy and biodiversity.

Key recommendations include:

- The continued development of agri-environment schemes to promote land management measures that reduce run-off generation and drainage and therefore, contribute to reducing both flooding and diffuse pollution;
- New regulations to control land drainage for both flood management and biodiversity;
- The use of flood defence block funding to fund one-off or ongoing capital land management activities and changes;
- Better information and training for land managers on how to manage land and soil to reduce run-off;
- Better linkage of the catchment flood management planning process with rural planning and budgetary mechanisms, for example national forestry strategies;
- The creation of 'catchment teams' with members from organisations responsible for water and land management, but with a single budget, to drive integrated catchment planning;
- The development of rural 'spatial plans' to prioritise water and flood management issues in certain catchments; and
- Better and increased use of environment and social Key Performance Indicators within flood management, and the development of more strategic cost/benefit tools to calculate the wider benefits of different approaches to flood management.

Study Aim and Objectives

The primary aim of this study, generated by the Land Use Policy Group, was to identify the potential for the integration of agricultural, forestry and biodiversity conservation policies with flood management in England and Wales. In addition to this, any overlaps with the Scottish frameworks were highlighted when analysing the scope for integration between the policy areas.

The specific objectives of the study were:

- To describe the existing flood management framework in England, Wales and Scotland (concentrating on the arrangements in England and Wales);
- To describe the rural land management factors that influence flood risk and extent;
- To identify and describe the policy, regulatory and budgetary control mechanisms;
- To describe the relevant organisations, and their roles and responsibilities;
- To analyse the scope for integration of the various policy areas;

- To organise and run a seminar to present the findings of the study to the Steering Group, members of the Land Use Policy Group and other stakeholders.

Study Approach

The approach adopted was to review the following aspects through a combination of literature review and consultation:

- The existing flood management policy, regulatory and budgetary frameworks;
- Key land use and management activities and practices that can impact on flood risk and extent and the environment (and which show most promise for future policy integration);
- Drivers that influence these activities and practices; and
- The role and responsibilities of each of the main actors in, and controllers of, existing policy.

Having gained this understanding, a 'gap analysis' of existing policy was undertaken to assess:

- How well it works at present;
- Whether and how it may need to be adapted;
- Whether strategic developments will help to address deficiencies; and
- What new policies may be needed to fill the gaps and responsibilities for them.

Key Land Use and Management Activities and Practices That Influence Run-off Generation

Based on the available data, the land use practices that increase flood risk and extent most significantly for each policy area are:

Agriculture:
- The pattern and scale of single land use operations;
- Land drainage, depending on the soil type and wetness regime (quantifiable evidence available);
- The move away from mixed agriculture to more specialised systems, and the consequent decline in on-farm organic matter for soil nourishment;
- Arable land management (such as untimely operations on susceptible soils), leading to soil compaction, puddling, capping and plough pans (quantifiable evidence available);
- Cultivating 'risky' crops such as maize (quantifiable evidence available);
- Grazing in certain geographical locations and under specific management regimes, leading to soil compaction (quantifiable evidence available); and
- The loss of on-farm water storage systems and features including ponds.

To a lesser extent:

- Water abstraction where there are large-scale commercial users of water.

Forestry:
Those practices that have minor effects are:

- Tree removal (quantifiable evidence available);
- Harvesting operations (localised impacts); and
- Drainage (localised impacts, declining with time).

Nature conservation:
- The requirements for high water tables in specific sites (may conflict with flood management as soil storage is reduced).

Main Opportunities for Integration (Policy, Budgetary, Regulatory and Organisational)

Based upon the findings of the evidence review, the following short-medium-long- term changes have been identified as practical opportunities to increase the integration between rural land management policy, funding, regulation and organisations, and flood management. Section 7 contains a wider range of more specific and detailed recommendations that will help to realise some of these changes.

(Short to medium- term)

- Full use of the opportunities in the reform of the Common Agricultural Policy, particularly the linking of specific actions required with the catchment flood management planning process and the new arrangements for payments.

- The further and continued development of agri-environment schemes to promote and fund land management measures that reduce run-off and soil erosion and therefore, reduce flood risk and extent.

- Better linkage of the catchment flood management planning process, rural planning and budgetary mechanisms, for example with national forestry strategies and rural development plans.

- Facilitate the use of flood defence block funding to fund capital land management activities and changes such as streamlining of funds for use in washland creation and floodplain restoration.

- Provision of information and training for land managers on practical measures to reduce run-off generation and therefore, contribute to reducing both flooding and diffuse pollution.

- Reviews of existing best management practice guidance on:

    - Flood management;
    - Washland and floodplain creation and restoration;
    - Soil management; and
    - Designing riparian zones and drainage buffers within forests

    to ensure that land management/run-off generating activities are taken into account.

Better and increased use of environment and social Key Performance Indicators within flood management, and the development of more strategic cost/benefit tools to calculate the wider benefits of different approaches to flood management.

(Medium to long- term)

- The creation of 'catchment teams', consisting of members from land and water management bodies, but operating under a single budget for joint and integrated action in each catchment.

- The development of rural 'spatial plans' to prioritise water and flood management issues in certain catchments. These would bring wider economic and environmental benefits in addition to better management of flood risk and extent.

- New regulations to control land drainage for both flood management and biodiversity.

- The development of a strategic flood risk assessment tool (including rural land management) for use in planning guidance (Planning Policy Guidance 25 and Technical Advice Note 15), and its use required for major land use changes in conjunction with Environmental Impact Assessment.

ACKNOWLEDGEMENTS

We would like to express our appreciation to the consultees who were involved with this study. Our principal consultees are detailed in Section 2.3.

We are also grateful to the Steering Group for their project management input. The Group comprised the following members:

- Chris Uttley (Countryside Council for Wales);
- Hilary Miller (Countryside Council for Wales);
- Stuart Pasley (Countryside Agency);
- Helen Richardson (Environment Agency);
- Louise Bond (Scottish Natural Heritage);
- Keith Kirby (English Nature); and
- Diana Mortimer (Joint Nature Conservation Committee).

Chris Uttley of the Countryside Council for Wales (CCW) acted as the client Project Manager. CCW also wishes to acknowledge the financial support of the Joint Nature Conservation Committee.

CONTENTS

1 INTRODUCTION

1.1 Study Background

Flooding is not a recent phenomenon and has caused severe damage and loss of life since records began. However, despite this long history, and significant investment over many years in flood defences, experience in recent years suggests that both the frequency of floods and the impacts they cause are increasing. The misery and damage caused most recently by the New Year 2003 floods, autumn 2000 floods and 1998 Easter floods serve to remind people of this natural phenomenon and its consequential risks. Recent figures from the Department of the Environment, Food and Rural Affairs (Defra) illustrate the scale of the present threat in the UK:

- 1.8 million residential properties;
- 140,000 industrial/commercial properties;
- > £200 billion total property value;
- 1.4 million hectares of agricultural land; and
- 5 million people.

Such a continuing and worsening situation is, at least in part, of society's own making at local, regional, national and global scales. Unsustainable approaches have been adopted in response to contemporary policy drivers to:

- Land management (for example drainage and ploughing for agriculture);
- River management (for example straightening, dredging, constraining within flood walls and embankments, and isolating from traditional floodplains); and
- Development in floodplains and flood risk areas.

Continuing such practices is likely to increase future flood risks, although evidence-based, quantitative data are lacking. In addition, changes in rainfall and sea level caused by climate change will further increase the risks of both river and coastal flooding. Those areas currently at risk will potentially be the most affected.

This continuing flood risk is the ultimate driver behind Defra's flood and coastal defence policy in England:

> "*to reduce risks to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures*".[1]

This policy recognises that the risk of flooding can never be absolutely removed. The use of the word 'sustainable' is critical and this concept underpins this study.

In England, the concept of sustainability has been embedded at the heart of government policy on flood management[2] to ensure that any new flood defence schemes have a view to their future impacts on local, regional and national environmental, community

[1] Defra. Strategy for Flood and Coastal Defence in England and Wales. Source: www.defra.gov.uk.

[2] Ministry of Agriculture, Fisheries and Food's (MAFF's). 2000. Flood and Coastal Defence Project Appraisal Guidance: Environmental Appraisal. Publication FCDPAG5.

and economic issues. Sustainability is also central to policies on agriculture, forestry, and diffuse pollution, and at a wider level, rural development. The devolved governments for Scotland and Wales, the Scottish Executive and the Welsh Assembly Government respectively, have binding legal duties to pursue sustainable development in all they do. This aim drives the development and delivery of more sustainable, lower cost approaches to flood management (for example upstream wetlands for flood storage or managed realignment). These approaches, if implemented effectively, can simultaneously deliver a wide range of added benefits to:

- The environment (for example enhanced biodiversity and reduced natural resource use);
- Communities (for example amenity, recreation and social equity); and
- The local, regional and national economies (for example minimised whole-life flood defence scheme costs, rural development and diversification opportunities).

The development of flood defence schemes must take place within the existing policy context. Schemes currently being developed are therefore partly restricted by a policy and legislative context that still largely reflects more engineering-based approaches to flood management.

However, the development of a future policy context that promotes, drives and enables the delivery of more sustainable approaches to flood management throws open the debate to include a variety of inter-related sectors, issues, policy areas and drivers. These include large and complex areas such as agriculture, forestry and biodiversity, each of which has its own set of policies, regulations and funding streams. At present, these policies and funding mechanisms can be conflicting or disintegrated.

The challenge for flood and environmental managers, to which the results of this study will contribute, is to think laterally about ways in which agriculture, forestry and biodiversity can help identify and deliver multi-value flood management, and to set up the policy framework to enable and facilitate it.

The Ministry of Agriculture, Fisheries and Food's (MAFF's) Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) 5 describes the need for a strategic framework within which to develop sustainable flood defence solutions. There are a number of crucial high level strategic issues and developments on the immediate horizon that make a study of how future flood, agricultural, forestry and biodiversity policies should be shaped and integrated extremely timely. The whole policy field is slowly moving towards a more strategic and catchment-based view of water resource and quality issues. This is being largely influenced by the following three key drivers:

- The European Union (EU) Water Framework Directive sets out to improve and protect the quality of water bodies via catchment-scale approaches to land use and pollution control etc. This Directive makes numerous references to enhanced policy integration in the water field.

Article 1 states that:

"The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;

(e) contributes to mitigating the effects of floods and droughts".

- The development of Catchment Flood Management Plans (CFMPs) and the implementation of Shoreline Management Plans are similarly moving the flood management debate onto a more strategic footing.

- The recent Defra Flood and Coastal Defence Funding Review for England has recommended consultation on different ways of funding and managing the delivery of flood defences in the future via Regional Customer Bodies (RCBs) interacting with the existing operating authorities at a catchment-scale.

Within the rural sector, the impact of land management activities on water flows and quality is gradually becoming recognised. The key potential direct or indirect drivers are:

- Devolution and the divergence of many policy areas (for example forestry) in Wales and Scotland has created an additional layer of complexity, while at the same time offering the opportunity to trial and learn from different approaches.

- Joined-up approaches to resource management. For example, the 2002 report of the Policy Commission on the Future of Farming and Food (the Curry Commission) recommended that:

  "future environmental schemes and, where appropriate, woodland schemes should include water management as an option for support…the Government should ensure that land management responses to flooding are eligible for funding from flood management budgets alongside more traditional methods of flood defence…aided by a rapid shift to whole-catchment planning and away from the current system. The farming industry should look to embrace water management as a viable 'alternative crop'".

  This view was mirrored in the Welsh Assembly Governments' strategy "Farming for the Future".

- The EU has put forward a proposal to replace the current direct support payments to farmers with a Single Farm Payment, which is not linked to production. Farmers would be free to use their payment as they wish, on condition that they maintain the land in good agricultural and environmental condition, and adhere to the relevant EU environmental legislation and other (non-environmental) regimes (termed cross-compliance).

- The current set of Rural Development Programmes for England, Wales and Scotland has the creation of a productive and sustainable rural economy, and the conservation and enhancement of the rural environment as key priorities. These are in the process of being reviewed and expire in 2006, potentially to be replaced by a revised set.

- Lord Haskins' Rural Delivery Review, which was published in November 2003, examined how the government can improve on the delivery of its commitment to rural areas in England. In particular, relevant areas of Defra, the Environment Agency, the Countryside Agency, English Nature (i.e. delivery of Defra's rural policies), National Park Authorities, Areas of Outstanding Natural Beauty Teams, Regional Development Agencies, the Forestry Commission, Small Business Service, Government Offices in the Regions, British Waterways and Local Authorities were considered. The review highlighted that there is poor accountability; a failure to satisfy regional and local priorities; too many players (for example delivery of sustainable land management is handled by at least six national agencies working with various regional and local organisations); lack of co-ordination; and confused customers. In particular, it is envisaged that a more integrated approach to sustainable land management can be achieved by minimising overlapping agendas (Haskins, 2003).

- Socio-economic changes are affecting rural and rural fringe areas. Particular challenges include the delivery of rural services (such as flood provision), making the countryside accessible for recreational purposes, and stimulating rural economic diversification.

- Technological opportunities are emerging that offer the potential to make policy delivery more efficient. For example, the whole farm approach could benefit from Geographical Information Systems to monitor and share data.

1.2 Aims and Objectives

The primary aim of this study, generated by the Land Use Policy Group, was to identify the potential for the integration of agricultural, forestry and biodiversity conservation policies with flood management in England and Wales. In addition to this, any overlaps with the Scottish frameworks were highlighted when analysing the scope for integration between the policy areas.

The specific objectives of the study were:

- To describe the existing flood management framework in England, Wales and Scotland (concentrating on the arrangements in England and Wales);

- To describe the rural land management factors that influence flood risk and extent;

- To identify and describe the policy, regulatory and budgetary control mechanisms;

- To describe the relevant organisations, and their roles and responsibilities;

- To analyse the scope for integration of the various policy areas; and

- To organise and run a seminar to present the findings of the study to the Steering Group, members of the Land Use Policy Group and other stakeholders.

1.3 Report Structure

This report is divided into nine sections. Section 1 describes the background to the study, whilst Section 2 details the study methodology. Section 3 presents an ecosystem approach to flood risk and extent of flooding. Sections 4 and 5 describe the current flood management framework in the UK; and factors that influence flood risk and the extent of flooding respectively. Section 6 presents the organisations and their roles and responsibilities, and details policy, regulatory and budgetary control mechanisms. Section 7 identifies and discusses the scope for the integration of agricultural, forestry and biodiversity conservation policies with flood management. Section 8 presents the conclusions and recommendations of the study, and should be included in 'local' guidance sheets.

2 METHODOLOGY

2.1 Our Approach to This Study

In summary, our primary activities in undertaking the work were as follows:

- Briefly summarise the existing flood management policy, regulatory and budgetary framework in England and Wales;
- Undertake a brief technical literature review to identify key land use and management practices and activities that can impact on flooding and the environment, and which show most promise for future policy integration;
- Identify and examine existing drivers that influence these practices and activities, focusing on those most likely to be suitable for future policy integration;
- Briefly describe the role and responsibilities of each of the main actors in, and controllers of, existing policy;
- Undertake a 'gap analysis' of existing policy to assess:
    - How well it works at present,
    - Whether and how it may need to be adapted,
    - Whether strategic developments will help to address deficiencies, and if not,
    - What new policies may be needed to fill the gaps and responsibilities for them;
- Prepare summary material of the findings to enable the production of guidance sheets and notes, potentially for use by future Regional Customer Bodies (RCBs) or similar groups; and
- Organise, run and attend a seminar to present the study's key findings and gain feedback.

This report will be relevant to a range of high-level policy groups such as the Department of the Environment, Food and Rural Affairs (Defra), the Welsh Assembly Government (WAG) and the Scottish Executive Environment and Rural Affairs Department (SEERAD), as well as Flood Defence Committees, informing ongoing policy reform. It is also envisaged that the report's output will be developed to provide 'local' guidance for RCBs or similar groups if appropriate, although this task is excluded from the scope of this study.

2.2 Project Team

The project was led by Lucy Bazeley who was overall Project Manager for the study and the principal contact with the Steering Group, with technical input from Dr Helen Stark. Firn Crichton Roberts (John Firn) and John Clegg Consulting (Guy Watt), and the Agricultural Development and Advisory Service (ADAS) (Paul Withers) supported the Posford Haskoning team, which also comprised a Flood Defence Engineer (Fola Ogunyoye) and Environmental Scientist (Liesbeth van Kampen-Brouwer).

2.3 Literature Review and Consultation

At the outset of the study, an on-line and off-line literature search was undertaken using a series of linked key words to identify relevant references. These references are detailed at the end of this report.

In addition, consultation was carried out with a number of key stakeholders, listed below in Table 2.1.

Table 2.1 - Consultees

Name	Organisation
Professor Edward Evans	Projects Officer for the Defra Land Use Project (FD2114) and lead contact on the Flood Defence Foresight Project
Noel Cleary	Defra (Responsible for managing the update of Defra's strategy for flood and coastal management)
Daniel Instone	Defra (Water quality)
Linda Aucott	Defra (Flood management)
Nigel Atkinson	Defra (Sustainable agriculture)
Martin Capstick	Defra (European wildlife)
Lee Searles	Local Government Association (England)
Brian Empson	Environment Agency
Tony Burch	Environment Agency
David Withrington	English Nature
James Marsden	English Nature
Tom Nisbet	Forestry Commission Research
Steve Gregory	Forestry Commission
Mark Pritchard	Forestry Commission, Cambridge
Simon Pryor	Forestry Commission, Cambridge
Crispin Thorn	Forestry Commission, York
Ruth Jenkins	Forestry Commission, Aberystwyth
Clive Thomas	Forestry Commission, Aberystwyth
Bob Macey	WAG
Dr Peter Jones	WAG
Mike Dunn	WAG
Dr Joe Howe	School of Planning and Landscape, University of Manchester
John Thomson	Scottish Natural Heritage
Philip Wright	Scottish Executive
Campbell Gemmell	Scottish Environment Protection Agency
James Fowlie	Convention of Scottish Local Authorities
Ben Thorne	Farming and Wildlife Advisory Group, Parrett Catchment

Consultation was focused and limited to specific questions targeted at the organisations shown in Table 2.1. Refer to the consultation document detailed in Appendix A. The comments received were incorporated into this report.

2.4 Steering Group Review

The Steering Group performed a review role through providing sources of information and additional contacts; and commenting on the methodology, reports and presentations. This was an essential aspect of the study, which enabled the output to be critically appraised and refined throughout.

2.5 Presentation of Findings

The study's findings are summarised in the following sections including Tables 5.1 - 5.4 (Section 5). This tabular format was selected to summarise a large amount of information and to allow the reader to gain an overview of the different aspects of the study.

3 AN ECOSYSTEM APPROACH TO FLOODING AND LAND USE

3.1 Flooding and Land Use

Flooding is a natural process and part of the hydrological cycle. *"Floods occur whenever the capacity of the natural or man made drainage system is unable to cope with the volume of water generated by rainfall"* (Richardson, 2003). Different run-off generation mechanisms operate in UK catchments, which reflect spatial and temporal variations in land use, climate, geology, soil type/s, vegetation and topography.

During the last three centuries, flood defence works and/or other activities such as river channel improvements (for example straightening, deepening and widening), containment by hard structures, land drainage and loss of flood storage have exacerbated flood risk to some extent. The indirect effects of engineering approaches to flooding are also evident, for example, floodplains isolated from the river have resulted in the loss of riffle/pool habitats and bankside vegetation, thereby affecting wetland flora and fauna (Royal Society for the Protection of Birds, 2001).

The impacts of land use and land management changes on run-off generation have not been clearly established, although significant quantifiable changes at the field (plot)-scale have been identified. For example, long-term studies in small catchments in the South Downs of south east England have shown a significant relationship between the presence of autumn-sown cereals, autumn rainfall and local flooding (Boardman *et al*., 2003 cited in O'Connell *et al*., 2003).

Evidence that land management-induced changes in run-off and drainage response are transferred to the surface water system is much less available. Most catchment monitoring studies have centred on upland catchments dominated by forest or grassland. While these studies have demonstrated that there is a tendency for water yields from forested catchments to be less than for upland pastures, the conclusions with respect to flood run-off production are unclear.

Modelling studies in larger catchments (approximately 100km^2 and above) have indicated that the impacts of land use and land management change on the catchment water balance and flow regime may be small, possibly due to compensating effects or regional impacts such as evapotranspiration. However, it is noteworthy that there are few UK studies in which a model has been applied to a catchment where change is known to have occurred (O'Connell *et al*., 2003).

Evidence that land use and land management- induced changes in surface run-off and land drainage impact on flood events is very limited, partly because very few studies have been undertaken with these specific objectives (O'Connell *et al*., 2003).

Whilst it is recognised that research with respect to rural land use and flood generation is currently ongoing (refer to Section 3.3), it is generally expected that the effect of rural land management on flood risk will be more significant for smaller rainfall events, reducing as the events approach extreme events. Other issues will inevitably affect the extent of their relevance. These include the state of the catchment before the main event commences (for example moisture deficit), local environmental conditions such as temperature (for example frozen or hard-baked ground) and the location of the area

concerned in relation to the catchment of the receiving watercourse (top or bottom of the catchment).

Identification of the catchment type (upland or lowland) is the first step in recognising which factors may be important (for example run-off, erosion, floodplain development etc.). It is possible to distinguish eight broad land uses, based on the type of catchment and predominant land use, although the relative proportions of the different land uses are not quantified. The catchment type encompasses factors such as soil type and hydrology, as well as associated properties including landscape morphology (slope, roughness etc.). The identification of the primary land use can then be used to further pinpoint key management practices influencing flood risk and extent within a catchment, and which measures are potentially relevant for reducing these.

Based on a review of the major catchments in England, Wales and Scotland, the following land uses are recognised:

Upland
Arable;
Mixed;
Pastoral;
Forestry;

Lowland
Arable;
Mixed;
Pastoral; and
Forestry.

The first three land uses in each category correspond with those identified as part of the Countryside Survey 2000 of Great Britain (www.cs2000.org.uk/report.htm). However, there are marked differences in the proportions of these land uses between and within England, Wales and Scotland. In 2002, crops and bare fallow comprised 30% of England's total land area. This contrasted with only 3% for Wales and 7% for Scotland. Scotland had the highest proportion of forest and woodland cover, constituting 17% of total land area, compared to 8% for England and 13% for Wales (Defra, 2003a).

The preliminary results of the 1996 land use survey for the UK revealed that arable or horticulture use comprised 52.8% of land cover in East Anglia compared to a figure of 18.1% for the Northern Region (http://geography.radley.org.uk/pdf/agriculture/UKsurvey.pdf). No regional data were available for Wales and Scotland as part of this survey.

3.2 Land Use, Flood Management and the Ecosystem Approach

With respect to land use and different land management practices, it is important to consider ecosystem functioning. This concept is described in detail below.

Hydrological, chemical, biological and physical processes taking place within ecosystems, such as the uplands of England, Wales and Scotland, control a wide range of environmentally beneficial functions including nutrient transformation, pesticide retention and habitat development. Ecosystem functioning results in the delivery of goods and services that are not only environmentally beneficial, but can also provide socio-economic benefits. Goods can include products for direct or indirect human use

such as timber and fisheries; and services such as flood alleviation and water quality enhancement. Ecosystem processes also interact with the structure of the ecosystem to deliver wider attributes such as biodiversity and cultural heritage. For example, wetlands may reduce the risk of flooding downstream and provide wildlife habitats (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

It should be acknowledged that benefits can be delivered at a distance from where environmental enhancement takes place. For example, good management of water at the farm-scale may also reduce flood risk downstream. Such enhancement can go hand-in-hand with improvements in fisheries, thereby delivering economic benefits. Given the potential benefits to all the policy areas within this study, there is a need to understand the environmental factors and interactions that control ecosystem functioning in order to establish the optimal land use and management practices supporting that functioning.

The 'ecosystem approach' has been adopted by the contracting parties as the framework for balancing the three key objectives of the Convention on Biological Diversity (UNEP/CBD/COP/4/Inf.9); that is conservation of biological resources, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. The Convention interprets the 'ecosystem approach' as a strategy for the integrated management of water, land and living resources that promotes sustainable use and conservation in an equitable manner. The Conference of Parties, government and international organisations are called upon to apply, where appropriate, the 'ecosystem approach' together with its underlying principles (for example the 'ecosystem approach' should be undertaken at the appropriate spatial and temporal scales) and points of guidance (for example enhance benefit sharing).

The 'ecosystem approach' is therefore an effective tool for implementing integrated land and water management, and in practice will be developed through catchment management planning. With respect to the study's objectives, it is important to identify ecosystem processes that are not being optimised to reduce flood risk and extent, and for which the future integration of agricultural, forestry and biodiversity conservation policies with flood management can achieve synergistic effects.

3.3 Relevant Research

The literature review identified other research projects recently completed, currently being undertaken or planned for the near future, which are relevant to this study:

- "Review of Impacts of Rural Land Use and Management on Flood Generation: Short-term Improvement in Modelling and Future Research Plan", being undertaken by a consortium including the University of Newcastle upon Tyne, Lancaster University, Cranfield University, British Geological Survey, and Institute of Grassland and Environmental Research (Defra/Environment Agency Project FD2114 co-funded by English Nature and the Forestry Commission).

- "Scoping the Broad Scale Modelling Hydrology Programme" (Defra Project FD2104).

- "Broad Scale Ecosystem Impact Modelling Tools: Scoping Study" (Defra/Environment Agency Project FD2108).

- "Re-vitalisation of the Flood Estimation Handbook Rainfall-run-off Method" (Defra/Environment Agency Project FD1913), being carried out by the Centre for Ecology and Hydrology (CEH)-Wallingford.

- English Nature project (jointly funded with Defra's Flood Management Division) "Integrated Washland Management for Flood Defence and Biodiversity", undertaken by Cranfield University.

- "Flooding on a 30-100 Year Timescale: Causes, Risks and Solutions" being carried out by the Office of Science and Technology - Department of Trade and Industry (DTi) (Foresight Project for the whole of the UK - www.foresight.gov.uk/servlet/Controller/ver=1778/userid=2/section1.pdf).

- In Wales, there is a joint three year project involving the Welsh Assembly Government, the Countryside Council for Wales, British Geological Survey, the Environment Agency and University College Wales (Aberystwyth) to test a dynamic modelling methodology on the Rivers Dee, Dyfi, Teifi and Upper Severn to predict flood risk.

- "Turning the Tide on Flooding", a report produced by the World Wildlife Fund for Scotland.

- Catchment Flood Management Plans (CFMPs). For example, the Severn Pilot has recently been completed. Further CFMPs will be undertaken in 2004.

In addition, there are a number of related projects including:

- A £5 million jointly-funded Flood Risk Management Research Consortium, led by the Engineering and Physical Sciences Research Council, and Natural Environment Research Council (NERC), is being set up to tackle the problem of flooding in the UK. This research will aim to link into the Defra/Environment Agency Joint Research and Development Programme. Individual work packages include the "Development of Multi-scale Modelling Tools" and "Whole Catchment Integration and Case Study Guidance".

- “New Forest LIFE III Riverine Restoration Project”.

- “Parrett Catchment Project”. Further details are given in Section 5.5.1.

- The University of Wales (Bangor), Coed Cymru and CEH (Bangor) are undertaking a land use/flooding study in Pontbren, mid Wales. This is part of wider research being led by Howard Wheater at Imperial College, London. A case study of Pontbren is detailed in Section 5.5.3.

- The government in England is preparing a strategy on diffuse water pollution from agriculture. The Welsh Assembly Government is currently assessing the scope for developing a strategy to address diffuse water pollution. The Scottish Environment Protection Agency (SEPA) also has a Diffuse Pollution Initiative, which began in 2001 and runs for three years.

4 CURRENT FLOOD MANAGEMENT FRAMEWORK IN ENGLAND AND WALES

4.1 Introduction

The current policy framework for flood and coastal defence in England and Wales is outlined in Ministry of Agriculture, Fisheries and Food (MAFF)/Welsh Office (1993). This policy is aimed at reducing the risks to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures.

The particular objectives of the flood and coastal defence policy are:

- To encourage the provision of adequate and cost-effective flood warning systems;
- To encourage the provision of adequate, technically, environmentally and economically sound and sustainable flood and coastal defence measures; and
- To discourage inappropriate development in areas at risk from flooding or coastal erosion.

Defra and the Welsh Assembly Government (WAG) have overall policy responsibility for all flood defence matters in England and Wales respectively. The delivery of the policies are carried out through the Environment Agency, formerly National Rivers Authority (NRA), who have general supervision over all matters relating to flood defence and other "Operating Authorities" with varying levels of supervisory and executive powers over specific locations.

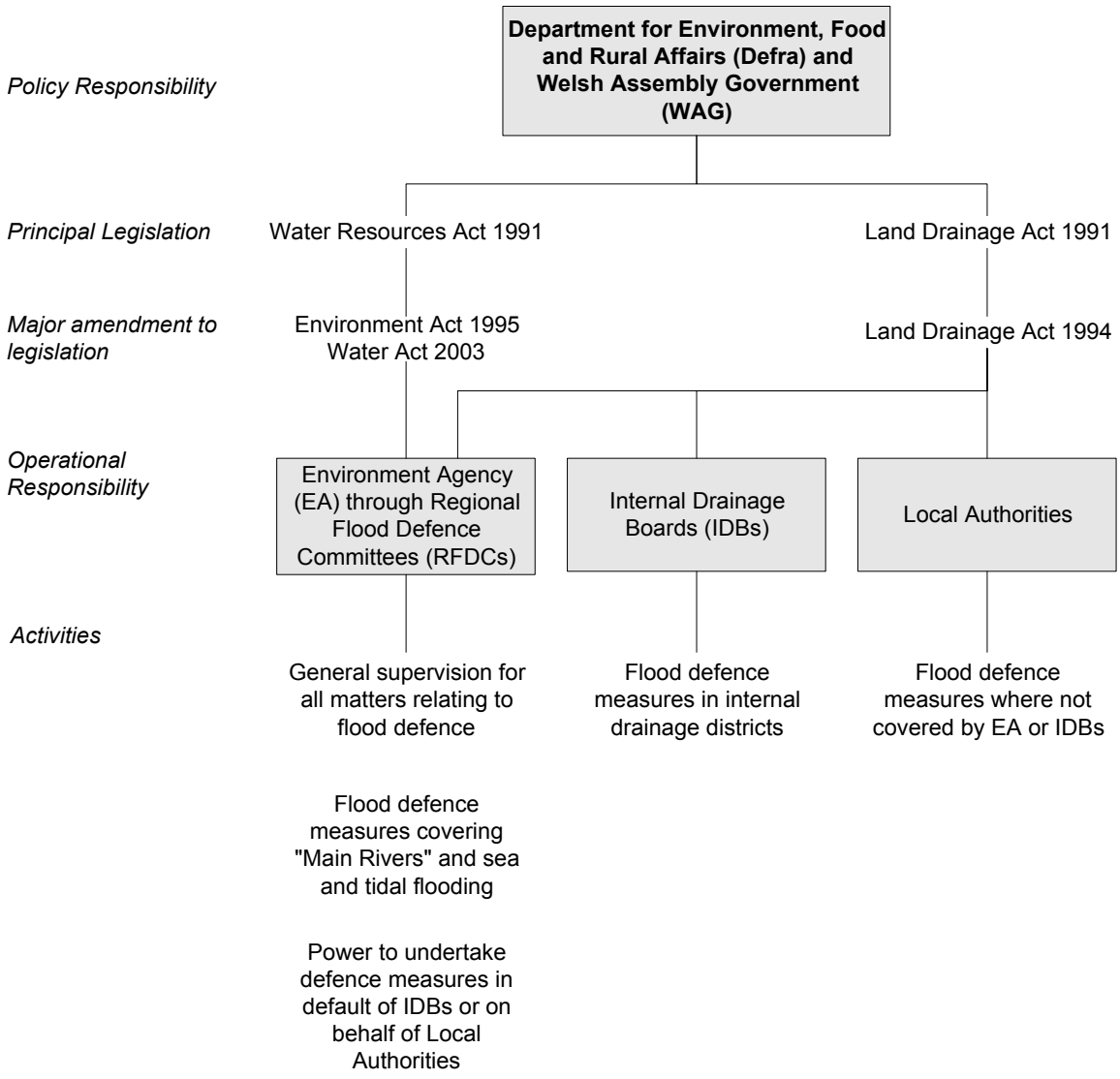
A number of changes in the organisation of flood defence and policy direction have occurred since 1993, making the current strategy out of date. In addition, there is also a need to accommodate emerging new drivers for change. The Department of the Environment, Food and Rural Affairs (Defra) is currently updating the 1993 policy

document in England to reflect these changes. The publication of the revised document is planned for October 2004. The Welsh Assembly Government (WAG) has also recognised the need for a revised document, but has not yet commenced formal update. It is however working closely with Defra in their ongoing update. A summary of the emerging strategic direction from the Defra update is outlined in Section 4.5.4.

4.2 The Flood Management Framework

The current organisation of flood management in England and Wales is shown in Figure 4.1.

Figure 4.1 - Flood Defence Organisation (updated from MAFF/Welsh Office, 1993)



4.3 Mechanisms Controlling the Flood Management Framework

EU Directives and UK legislation over the past ten years continue to shape flood defence policy. Some key ones are outlined below.

4.3.1 Environment Act 1995

The Environment Act 1995 provided for the establishment of the Environment Agency and outlines its duties and powers for flood defence and other functions. In particular, the Act extended the definition of flood defence functions to include water level management. The Act also places a duty on the Ministers and the Environment Agency to further conservation, and the conservation and enhancement of natural beauty so far as may be consistent with their functions and guidance relating to the achievement of sustainable development.

4.3.2 Land Drainage Act 1994

The Land Drainage Act (LDA) 1994 significantly added to the environmental and recreational obligations of the Environment Agency, Internal Drainage Boards (IDBs) and Local Authorities with respect to carrying out their flood defence functions under LDA 1991. In particular, the Act imposes duties on these authorities to further conservation, enhance natural beauty and take account of the effect of their work on the beauty or amenity of any affected area. It also imposes a duty on the Environment Agency, IDB or Local Authority to consult English Nature or the Countryside Council for Wales before authorising any works that might affect or damage a Site of Special Scientific Interest (SSSI) or particular lands of special interest, where they have been notified.

4.3.3 Water Act 2003

The recently enacted Water Act 2003 further enhances the Environment Agency's supervisory duties and powers to carry out flood defence and drainage works. In particular, it provides new powers to allow the establishment and abolishment of Regional Flood Defence Committees (RFDCs), and to revoke local flood defence schemes and drainage works. The Water Act also makes the Environment Agency the enforcement authority under the Reservoirs Act 1975.

4.3.4 Water Resources Act 1991

The Water Resources Act (WRA) 1991 is primarily an Act relating to the NRA (now Environment Agency) and the matters in relation to which it exercises its functions. It covers among other functions those relating to flood defence and land drainage. The Act gives the Environment Agency comprehensive control powers over "Main Rivers" (as defined by MAFF (now Defra)). Some of the particular powers and duties imposed on the Environment Agency by the WRA 1991 include the following:

- **Supervisory duty** - a duty to exercise general supervision over all matters relating to flood defence.
- **Surveying duty** - duty to carry out surveys in the areas in relation to which it carries out its flood defence functions.

- **Executive powers** - in connection with “Main Rivers”, powers to maintain existing flood defence and drainage works, improve existing works and construct new works, which is extended to ordinary watercourses where the works are for the purpose of defence against sea or tidal water.
- **Flood warning powers** - to provide flood warning systems and to install and maintain apparatus required for them.
- **Regulatory powers** - as the consenting authority for the erection, alteration or repair of any structure in, over or under a “Main River”, and for the erection or alteration of any structure designed to contain or divert the floodwaters of a “Main River”.

In carrying out the above functions, the WRA 1991 imposes the duties below on the Environment Agency to such an extent that it considers desirable, generally to promote:

- The conservation and enhancement of the natural beauty and amenity of inland and coastal waters, and of land associated with such waters;
- The conservation of flora and fauna which are dependent on an aquatic environment; and
- The use of such waters and land for recreational purposes.

These duties are further enhanced by the LDA 1994.

4.3.5 European Union Directives

The Habitats Directive, Wild Birds Directive and the Water Framework Directive impose the need for consideration of the effects of flood management activities on designated sites and the natural environment in general. As priorities and environmental targets are developed, their effects will continue to shape the policies for flood management and their delivery.

The Water Framework Directive is the most substantial piece of EU water legislation produced to date, although it is primarily concerned with ecological status (water chemistry, water resources and aquatic hydromorphology) of aquatic ecosystems rather than flooding. It imposes a requirement for Member States to work towards and achieve

at least “Good Ecological Status” in all bodies of surface water, and also to prevent deterioration in the status of those water bodies. However, some water bodies will only be required to achieve “Good Ecological Potential”.

A key objective of the Directive is to establish a register of protected areas, for example areas designated for the protection of habitats or species under the Habitats and Species Directive, and/or Birds Directive. In this way, it provides for a higher level of protection for protected areas.

The relevant competent authorities, in this study, the Environment Agency and the Scottish Environment Protection Agency (SEPA), are responsible for the implementation of the Directive.

The timetable for key activities is shown below in Table 4.1.

Table 4.1 - The Water Framework Directive: Key Activities 2004-2015 (Environment Agency, 2003a)

Date	Key Activity
2004	Complete first characterisation and assessment of impacts on river basin districts. Establish a register of protected areas in each river basin district.
2005	Identify significant upward trends in groundwater and establish trend reversal.
2006	Establish environmental monitoring programmes.
2007	Publish an interim overview of the significant water management issues in each river basin district for general consultation.
2008	Publish draft River Basin Management Plans (RBMPs) for consultation.
2009	Finalise and publish first RBMPs. Finalise Programme of Measures to meet objectives.
2012	Ensure all measures are fully operational.
2013	Review characterisation and impact assessment for river basin districts. Publish an interim overview of the significant water management issues.
2014	Publish second draft RBMPs for consultation.
2015	Achieve environmental objectives specified in first RBMPs. Finalise and publish second RBMP with revised Programme of Measures.

The EU Soils Strategy and forthcoming Soils Directive focus on the sustainable use of soil. A Soil Protection Strategy baseline paper was formulated in June 2002. Eight main threats were recognised: erosion, decline in organic matter content, contamination, sealing, compaction, decline in biodiversity, salinisation, and floods and landslides. These issues will be addressed in the Soils Directive.

The EU proposal for an Environmental Liability Directive was published in January 2002. This is intended to prevent and restore environmental damage such as land contamination, damage to biodiversity and water pollution. Operators causing damage

would have to carry out, or pay for the cost of, restoration. However, in the light of the complex issues involved, it is unlikely that the Directive will be in force much before 2006/2007 (www.freshfields.com/practice/environment/publications/pdfs/2852.pdf).

4.3.6 Planning and Development Policy

Planning and development policy in England and Wales has given particular consideration to the management of flood risk. In England, the Department of Transport Local Government and Regions (DTLR), now the Office of the Deputy Prime Minister (ODPM), published the Planning Policy Guidance Note (PPG) 25 on "Development and Flood Risk" in 2001 to control the flood risk issues pertaining to new developments in England. A similar document for Wales, Technical Advice Note (TAN) 15 is currently being updated by the WAG. PPG 25 is due to be reviewed in 2004. These documents are primarily targeted at residential, commercial and industrial developments. The revised documents will continue to affect the way flood risks arising from new developments are managed.

Some potential flood risk issues from forestry, agricultural and similar rural activities are addressed during the planning process, where formal planning approval is required. However, there are many instances, for example the use of land management practices that increase flood risk and extent, when no control is exercised.

4.3.7 Environmental Impact Assessment Regulations

As detailed in Section 4.3.6, forestry and agriculture are subject to planning regimes and passage through Environmental Impact Assessment (EIA) Regulations.

The specific regulations are: The Environmental Impact Assessment (Forestry) (England and Wales) Regulations 1999, which amended the 1998 Regulations. Potential forestry projects which come under these Regulations, and for which the Forestry Commission must decide whether an EIA is required are: deforestation, afforestation, forestry roads and forestry quarries. Any proposer must submit an Environmental Statement in support of their proposals under the Regulations, which came into force in September 1999. Thresholds have been introduced by the Forestry Commission to define those forestry projects, which will not normally need to be considered for EIA. In addition, sensitive areas are defined where thresholds do not apply, or thresholds are lower. Exceptionally, the Forestry Commission or government authority may require a determination to be made for projects below thresholds.

EIA procedures also apply to projects for changing the use of land by bringing uncultivated land or semi-natural areas into intensive agricultural use in England, Wales and Scotland. While the Regulations do not define 'uncultivated land and semi-natural areas', the intention is to apply the EIA arrangements to unimproved grassland, heath and moorland, scrubland and wetlands. The types of 'projects' that fall within the definition include:

- Cultivations (such as ploughing, rotavating and re-seeding);
- Clearing vegetation or land (by a range of means, for example physical removal and burning); and
- Introducing livestock at intensive stocking rates, or increasing current stocking rates to intensive levels.

EIA legislation is already in place for certain water resource projects (such as water abstraction greater than $20m^3$ in any period of 24 hours for irrigation purposes) and land drainage operations.

In addition, the new EU Strategic Environmental Assessment Directive sets a minimum assessment framework for the preparation of plans in a range of sectors, including water management. Strategic Environmental Assessments (SEAs) will be produced for each Catchment Flood Management Plan (CFMP). CFMPs are described in more detail in Section 4.5.3.

4.4 Key Organisations and Actors that Impact on Mechanisms

4.4.1 Department of the Environment, Food and Rural Affairs (Defra) and the Welsh Assembly Government (WAG)

Defra (central government department) and the WAG (devolved administration in Wales) are the bodies which have policy responsibilities for flood defence. They set policy aims, objectives and targets for the "Operating Authorities" (Environment Agency, IDBs and Local Authorities). As empowered under the LDA 1991 and WRA 1991, the relevant Ministers may pay grant to drainage authorities to implement flood and sea defences. All such plans and schemes have to meet technical, economic and environmental criteria, which are backed up by a suite of Defra guidance (also adopted in Wales) and legislation. In addition to the appraisal process, a further scheme prioritisation process is carried out in England, utilising a multi-criteria approach involving economic, social and environmental considerations. This prioritisation process is not adopted in Wales, as the available budget is historically more than the cost of schemes considered worthwhile following the appraisal process (Dr Peter Jones, WAG, *pers*. *comm*.). This situation may change in the future due to climate change, development etc.

4.4.2 Environment Agency

As detailed in Section 4.3.4, the Environment Agency's responsibilities are set out in the WRA 1991, LDA 1991 and 1994, the Environment Act 1995 and the Water Act 2003.

The executive powers of the Environment Agency are permissive, meaning that they have the discretion to choose whether or not to carry out flood defence works. There is no statutory duty to carry out such works. All of the Environment Agency's functions are carried out through Regional Flood Defence Committees (RFDCs). These committees may, in turn, delegate functions to Local Flood Defence Committees (LFDCs). Of the ten RFDCs in England and Wales, only four currently have LFDCs.

The Environment Agency is funded, for flood defence purposes, by a levy on Local Authorities and by grant towards capital works from Defra in England, and by the WAG in Wales.

The Environment Agency is also a statutory consultee with respect to the implications of development proposals on flood risk and the environment.

4.4.3 Internal Drainage Boards

Internal Drainage Boards (IDBs) are operating authorities with duties to exercise general supervision for all matters relating to land within their drainage district, as given under the LDA 1991 and 1994. They also have permissive powers to carry out work on all watercourses within their area.

There are approximately 250 IDBs in England and Wales. There has been a recent trend towards their amalgamation into larger boards and the formation of consortia, leading to lower numbers of unitary IDBs. Further amalgamations are expected to occur as a result of the requirements of Defra (in response to the Funding Review) that small IDBs in England merge to form larger units capable of effective management or risk being addressed. Refer to Section 4.5.2 for a summary of the recommendations of the funding review.

The IDBs are funded through direct charges on agricultural land occupiers within their Internal Drainage District and from special levies on Local Authorities. Defra and WAG support capital schemes by IDBs through grants.

4.4.4 Local Authorities

Local Authorities that are operating authorities according to the LDA 1991 are English district or borough councils and unitary councils (for example in Wales). They have permissive powers to make or maintain drainage works for the drainage of land. These powers are restricted to works that are not the responsibility of the Environment Agency or an IDB.

Local Authorities are funded for their flood defence works by locally raised council tax, and from grants from Defra and WAG. In England, they also obtain some funding from the ODPM to support the levies they pay to the Environment Agency and IDBs, as well as their own spending on flood and coastal defences.

The Local Authorities' role in relation to planning also requires that they consider the implications of any proposed development on flood risk in accordance with PPG 25 and TAN 15. However, questions have been raised recently as to whether more prescriptive guidance is required.

4.5 Summary of Future Trends and Drivers in the Flood Management Framework

The current policy direction is being heavily influenced by a number of issues. Some key ones are highlighted below:

- The gradual shift from flood defence to flood risk management;
- The recent flood and coastal defence funding review;
- The renewed focus of Defra, Welsh Assembly Government and the Scottish Executive on sustainability as a key underlying principle for all their functions (refer to Section 1.1);
- The implementation of CFMPs;
- The formation of Regional Customer Bodies (RCBs) or similar groups;
- EU environmental legislation; and
- Country-based planning legislation.

In addition, key climate change impacts may influence the response to flooding. These impacts include:

- Change in the rainstorm intensity for a given frequency;
- Change in the prior wetness of a catchment at a particular storm season; and
- A lower expectation of frozen ground and a shorter season for this surface impermeability.

(Institution of Civil Engineers, 2001).

Climate change is discussed in more detail in Section 5.1.2.

4.5.1 Shift Towards Flood Risk Management

There is a general shift in focus from providing defences to managing flood risk. This is particularly evident in the naming of Defra's responsible division in England as "The Flood and Coastal Erosion Risk Management Division". Similarly, the Environment Agency is also currently finalising its relevant strategy for reducing flood risk, in "The Strategy for Flood Risk Management (2003/04 – 2007/08)".

This shift reiterates the focus on integrated river basin management. The focus on reducing flood risk implies having whole catchment approaches that allow the targeting of high risk areas where the risk can most effectively be reduced. CFMPs will be used to assess flood risk at a larger scale. While the above measures target effective reduction in the probability of flooding, the impact of floods will also be targeted through effective land use planning, regulation, flood warning and emergency response.

A key part of reducing the impact of floods is the prevention of inappropriate developments, which will require closer working between Defra and the Office of the Deputy Prime Minister (ODPM), which has overall responsibility for development planning in England. Closer working will also be required between Defra and the Office of Science and Technology (part of the Department of Trade and Industry) regarding the understanding of long-term flood risk issues being researched through their Foresight programme.

Despite flood and coastal defence being only 1% of Defra's annual spend for England, and an even smaller percentage of WAG's spend, it is considered to be a high and increasing risk (particularly due to climate change) by both bodies, hence the particular focus it receives. The emphasis on flood risk management should also imply more sustainable management, allowing more environmentally sensitive approaches, particularly in areas of low flooding risk.

4.5.2 Flood and Coastal Defence Funding Review

A review of the flood and coastal defence funding mechanisms in England and Wales was announced in summer 2001 as an outcome of the UK government's spending Review 2000. The report on the review was published in September 2001. The review and the delivery plans by Defra and WAG will make significant changes to the way flood defence is delivered. Key areas include:

- Identifying and transferring the responsibility of ordinary watercourses, which create the greatest flood risk ("critical ordinary watercourses") from relevant IDBs and Local Authorities to the Environment Agency by re-classifying them as "Main Rivers". This will make the Environment Agency responsible for all rivers presenting the greatest flood risk. It should also streamline the management of high flood risk areas and make responsibilities clearer to the public.

- Amalgamating IDBs and enhancing their organisation and management, to make them more in line with best modern practice, particularly in terms of nature conservation. In England, the possibility of all IDBs coming under the jurisdiction of the Local Government Ombudsman is being investigated.

- Streamlining the current two-tier structure of Flood Defence Committees through which the Environment Agency carries out its flood defence activities to a single tier body; referred to as Regional Customer Body by the Funding Review Report. Both Defra and WAG are working towards the abolition of LFDCs and creation of a single tier of RFDCs. The RFDCs are likely to be re-constituted in line with the structure suggested for the Regional Customer Bodies. They are presently consulting on appropriate numbers of RFDCs, particularly where LFDCs are being abolished. The new structures are due to be in place by April 2005. The power to abolish LFDCs or create new RFDCs has been provided within the new Water Act 2003. Currently, RFDCs only cover Environment Agency work, however the existing Defra and WAG proposals do not seek to extend this to IDBs. This is not exactly in line with the funding review recommendations, which indicated one "Operating Authority" (i.e. the Environment Agency), delivering its functions through the RCBs.

- Introducing Block Grant to the Environment Agency for capital works (i.e. replacing the existing scheme-specific grant). The ability to replace the existing scheme-specific grant has also been enabled by the Water Act 2003. Defra and WAG both plan to pay block grants to the Environment Agency for all capital and possibly, revenue flood defence works from April 2004. In Wales, the possibility of providing revenue block grants will depend on the options for RFDCs adopted following consultation. This will remove funding uncertainties that currently exist and allow the Environment Agency to plan better over a longer timeframe. It will also allow funds to be spent on areas that the Environment Agency judges would best reduce flood risk.

On a scheme by scheme basis, the plan in both England and Wales is for economic, environmental and technical viability and prioritisation to continue to be undertaken in some form. This is because there is still a need to ensure that overall objectives such as value for money, reduction of flood risk, sustainability etc. are being achieved.

For Environment Agency schemes, Defra in England and WAG in Wales will no longer be involved in scheme by scheme approvals, except where the value exceeds a threshold (as each body sets). Approvals will generally now be at the strategic level, rather than the scheme level. As a result, Defra and WAG are likely to introduce some forms of performance measures against which the Environment Agency would be evaluated.

Defra and WAG will continue to approve individual schemes forwarded by the IDBs or Local Authorities.
Other issues regarding new funding streams and streamlining funding approval procedures are proposed, although the delivery approaches are still evolving.

4.5.3 Catchment Flood Management Plans and River Basin Management Plans

The Institution of Civil Engineers' Presidential Commission report "Learning to Live With Rivers" states:

> *"The Commission concludes that a more strategic catchment based approach is essential in tackling fluvial flood alleviation".*

(Institution of Civil Engineers, 2001).

With this in mind, Catchment Flood Management Plans (CFMPs) are intended to be high level strategic documents that lead and deliver flood defence policy for the river catchments of England and Wales. The Plans will provide a holistic approach to risk management by assessing the effect of likely scenarios such as changes to land use, climate change and development.

Following the review of CFMPs in five pilot catchments, guidance for the production of CFMPs and a programme of plans has been developed. It is anticipated that approximately 80 CFMPs would be produced between 2004 and 2007.

River Basin Management Plans (RBMPs) are expected to be at larger scales of coverage compared to CFMPs. The current plan is that the boundaries, when drawn up, will either be the same (for large CFMPs), or the boundaries of a number of CFMPs would completely 'nest' within a RBMP boundary.

4.5.4 Defra's Strategy for Flood Management and Coastal Erosion

A strategy for Flood and Coastal Defence in England and Wales was produced in 1993. Due to a number of key changes since 1993 and new drivers for change, Defra recently commenced the process of updating the 1993 strategy to one which they consider will take flood management through the next 10 to 20 years. WAG is actively involved in the Defra update, and anticipates making formal plans for a Welsh update soon. The strategy completion is planned for October 2004 and as part of the strategy development, Defra has set up a Stakeholders Forum to enable continuous engagement with the industry.

The key principles on which to base the aims and objectives of the strategy are beginning to emerge. These are outlined below:

- The first priority of flood defence is to save lives. Issues about appropriate standards of defence and extreme event management would need to be addressed.

- There is recognition of the need for a holistic approach, particularly the consideration of a variety of ways to manage flood risk apart from putting up defences, and the provision of cost-effective solutions that better deliver multiple objectives.

- The importance of the concept of sustainable development, combining flood defence considerations with biodiversity and long-term sustainability, ensuring environmental improvements, and community /social considerations are integrated into flood management solutions.

- Planning for what should be done when a decision is made not to provide flood protection.

In summary, the above direction recognises that sustainability is at the heart of future flood management, with the three pillars of sustainability (economic, environment and social issues) featuring significantly in management decisions. The move towards managing flood risk in a variety of ways and delivering multiple objectives provides opportunities for better rural land management to be considered as part of flood risk management, with the opportunity to deliver other socio-environmental objectives as well. One of the challenges that would have to be addressed is the streamlining of processes for combining funds from various funding streams (across government departments and ministries, EU etc.) and political issues surrounding land/habitat loss and compensation across local/regional/other areas, boundaries or ownerships.

5 FACTORS THAT INFLUENCE FLOOD RISK AND EXTENT OF FLOODING

5.1 Introduction

This section identifies key factors that influence flood risk and extent in relation to the various land uses detailed in Section 3.1, as well as opportunities and barriers to change.

Many areas of the UK have experienced land drainage, followed or accompanied by ditching and ploughing for agriculture and forestry. In addition, traditional riparian zones have been lost due to the drainage of lowland wetlands, farming right up to the river's edge, and the canalising and embanking of rivers.

Agricultural production has intensified since the Second World War, with less diversified systems (for example less mixed agriculture, an initially narrower range of crops and limited rotations), and the replacement of natural manure by artificial fertilisers on lowland farms. New management practices, partly related to mechanisation, have also reduced the coverage of traditional crops (for example hay) and replaced traditional cultivation practices (for example spring cereal sowing). However, it should be recognised that there is spatial variation in this picture of agriculture throughout England, Wales and Scotland. For example, agriculture in East Anglia is primarily arable compared to more mixed systems in the Welsh Marches. The benefits have included an increased area of arable land and rough pasture; and increased economic returns from crop, sheep and cattle farming. The present growth of organic farming may begin to reverse these processes and hence, its effects should be addressed in future policy changes.

Due to their potential effect on the storage capacity of the soil and run-off, these land use and land management changes have exacerbated the risk and extent of flooding. In some cases, there has also been damage to soils and water through the leaching of nutrients (such as nitrate and phosphate) into rivers and groundwater, and increased erosion and sedimentation, as well as damage or destruction of wildlife habitats. However, at the catchment-scale, there is relatively little quantified long-term information on the impact of different land uses on the quantity and quality of water flows, and in relation to each other.

At the same time, there has been a significant increase in forestry cover during the 20th century. Up to approximately the end of the 1980s, new areas of woodland were established in England and Wales, particularly conifers in the uplands, in order to create a strategic reserve of timber. Forestry policy now aims at delivering the sustainable management of Great Britain's existing woods and forests, the expansion of the woodland area to provide greater benefits to society, whilst still encouraging the production of commercial timber and other non-timber market benefits. In 2000, woodlands covered 8.4% of the land area of England, and 13.8% of the land area of Wales. In England, broadleaved woodland is the dominant type representing 52.1% of all woodlands, with conifers comprising 25.6%. In Wales, conifer woodlands represent 47.9% of all woodlands, and broadleaves 37.3%.

In this section, those agricultural, forestry and nature conservation practices that significantly exacerbate or reduce the risk and extent of flooding are identified, focusing on those practices that offer the greatest potential to facilitate better flood management. The selection of these 'significant' practices has been based on the following criteria:

1. It is anticipated that the most beneficial effects on flood risk and extent will be derived from a catchment-based approach, involving a combination of measures aimed at achieving a well-balanced and well-organised distribution of arable and pastoral farming, forestry and natural areas.

2. The soil can be considered as the first line of defence against flooding (Environment Agency[a], Undated). The soil serves as a storage area for water that infiltrates the upper layers. Soil with a good natural structure 'acts like a sponge', and can, depending on the soil type, retain up to 40% water by volume (Hollis and Thompson, 2003). A protective layer of healthy, robust vegetation; an extensive root system; an open soil structure; and a layer of organic matter on the surface facilitate effective infiltration and drainage through the soil (Environment Agency[a], Undated). In this way, the amount of potential run-off is reduced, as well as the magnitude of the peak flow. Land uses and land management practices that increase the capacity of the soil to detain water in its passage, or to absorb it and return it to the atmosphere, therefore offer potential for flood mitigation.

3. Delaying run-off and increasing the surface storage capacity of the catchment can potentially reduce the risk of flooding downstream. In addition, controlled storage can offer additional benefits for water management, such as maintaining water levels during shortage. Land uses and land management practices that increase the potential of the catchment to delay or store run-off also offer scope for flood mitigation.

   "However, any resulting widespread increase in infiltration should be assessed in terms of impact on catchment scale flood risk" (O'Connell *et al*., 2003).

5.1.1 Patterns and Scales of Land Use

Patterns and scales of agriculture and forestry may also be important, although empirical data are lacking. If the pattern of land use is inappropriate, the potential gains in reducing flood risk under normal patterns of rainfall are unlikely to be realised. For example, in general terms, if there is a single use of an area of land for arable crops, then there is likely to be a greater risk of run-off compared with a mixed pattern of

agriculture over the same area of land (due to better soil texture, better interception etc. in the latter case) unless intense rainfall occurs. However, a careful assessment of the impacts of agriculture and woodlands on flood risk would need to be made prior to changing the balance of these land uses. Whilst there is little quantitative data available, it is possible that woodlands, depending on their age and structure, will intercept more precipitation than grassland (for example due to their greater surface area), which may result in greater evaporation of water and reduced run-off.

Patterns are also evident in relation to the presence of water bodies (for example lakes, ponds and streams) within a catchment. The connectivity of these water features and hydrological routes may mean that 'hot spots' increase flood risk and extent. For example, gateways located at the bottom of fields.

Likewise, the scale impacts of certain types of individual land uses may be significant. Much of East Anglia is used for arable agriculture including sugar beet production. This may lead to potentially greater flood risk at certain times of the year, under normal patterns of rainfall, than if there had been more traditional mixed patterns of agriculture. However, if woodlands were perceived as one solution for reducing flood risk, there could be conflicts between summer water losses and increased flood storage.

It is also envisaged that a balanced catchment approach will conserve or enhance archaeological interest, cultural heritage, landscape quality, water quality, biodiversity and recreational value. Land uses and land management practices that result in wider benefits increase the sustainability of the catchment, and potentially facilitate funding and public support for changes. Land uses and land management practices that can be integrated with flood management therefore offer the potential for sustainable catchment management.

It is important to recognise that the increased urbanisation of rural land, not just via the conversion of land into the built environment, but also through infrastructure development (such as roads and motorways), has impacted upon the capability of catchment areas to trap and retain rainfall. Such land use changes and their consequences for flooding and flood management policies requires further investigation, although urbanisation is excluded from this study.

As detailed in Section 3.1, there is limited quantitative data relating to the effects of changes in land use and land management practices on the flood hydrology of catchments. For this reason, it is in most cases only possible to discuss the *potential* effect of a particular land use or land management practice on flood risk and extent, based on the evidence available. In turn, there are uncertainties about the specific effectiveness of possible mitigation measures (such as restoring the natural storage of soil), although some generalisations can be made.

In a statement on "Wetlands, Land Use Change and Flood Management" (Defra *et al*., 2003), it is stated that *"while recognising the limitations of the methods currently available for analysis at catchment scale, those developing Catchment Flood Management Plans should be encouraged to consider the full range of potential approaches to future flood risk management. These should include the impact of changes in run off and alternative uses to flood plain use"*.

5.1.2 Climate Change

The UK Climate Impacts Programme (UKCIP) was established to provide an assessment of the impacts of climate change in the UK. While the number of variables and interactions make predictions difficult, climate change scenarios (based on Low Emissions, Medium-Low Emissions, Medium-High Emissions and High Emissions) have been developed for the UK. These scenarios present information on the possible changes in the climate over the 21st century.

The key findings are as follows:

- *The UK climate will become warmer*.

By the 2080s, the mean annual temperature may increase by between 2°C for the Low Emissions scenario and 3.5°C for the High Emissions scenario. However, there will be greater warming in the south and east, and there may be greater warming in the summer and autumn.

- *High summer temperatures will become more frequent, with very cold winters becoming increasingly rare*.

- *Winters will become wetter and summers may become drier throughout the UK*.

The relative changes will be largest for the High Emissions scenario and in the south and east of the UK, where summer precipitation may decrease by 50% or more by the 2080s and winter precipitation may increase by up to 30%. Under the High Emissions scenario, summer soil moisture may be reduced by 40% or more over large parts of England by the 2080s.

- *Snowfall amounts will decrease throughout the UK*.

The reductions in the mean snowfall over Scotland may be 60-90 % (depending on the region) by the 2080s for the High Emissions scenario.

- *Heavy winter precipitation will become more frequent*.

By the 2080s, heavy winter precipitation intensities that are currently experienced approximately once every two years, may become between 5 and 20 % (Low Emissions - High Emissions) heavier.

- *Relative sea level will continue to rise around most of the UK's shoreline*.

By the 2080s, sea level may be between 2cm below (Low Emissions) and 58cm above (High Emissions) the current level in western Scotland, although between 26 and 86 cm above the current level in south east England.

- *Extreme sea levels will be experienced more frequently*.

(http://www.ukcip.org.uk/climate_change/main_future_uk.htm).

Climate change is therefore likely to modify the key hydrological processes functioning within a catchment (for example the routing of water through the soil), although the specific details are currently unknown. Certain land uses may also be favoured over others in the future. Research is required to better understand how different catchments are likely to respond under future climatic conditions.

5.1.3 Section Structure

In the following sections, those agricultural, forestry and nature conservation practices identified as (potentially) significantly exacerbating or reducing the risk and extent of flooding are described. After a brief description of the land use, each relevant land management practice is discussed under the following headings:

- **Description of the practice;**
- **Area/s of relevance:** Identification of the land uses[3] for which the practice is relevant; and
- **Opportunities/barriers to change:** Alternative methods or practices, which can potentially mitigate the risk and extent of flooding, and provide wider benefits such as described previously. Only those practices that were considered to be promising for future integration are described further. It is anticipated that certain measures will be more effective in some catchments than others, and more effective within specific parts of a catchment at certain times, and hence where relevant and known this is indicated. Conversely, barriers to change (where known) are identified.

Table 5.1 summarises the potential impacts on flood risk and extent, additional impacts (for example with respect to recreation and biodiversity), relevant land uses and land management practices, and opportunities for change in relation to each land management practice.

Gravel/sand extraction and other land uses that are known to, or may have, an impact on flood risk and extent, are beyond the scope of this study.

5.2 Agriculture

General Description

There is a growing awareness that agricultural land use and land management practices can have an impact on run-off generation (Environment Agency[a], Undated; Coulthard and Macklin, 2001; and Environment Agency and Lewin, Fryer and Partners, 2003).

[3] Land uses: **Upland** 1. Arable 2. Mixed 3. Pastoral 4. Forestry **Lowland** 5. Arable 6. Mixed 7. Pastoral 8. Forestry.

Table 5.1 - Summary of the Impacts of Agricultural, Forestry and Nature Conservation Practices that Exacerbate the Risk and Extent of Flooding

Activity	Practice	Land Use	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
AGRICULTURE	Drainage and water level management	See below	Response will vary according to soil wetness regime, storage capacity etc. Refer to Section 5.2.1.	May promote siltation and weed growth in drainage channels.	Sustainable land management strategies: adoption of erosion protection measures, and vegetating ditch banks etc. Reviewing system of land drainage.
	Use of lowland floodplains as agricultural land (via drainage)	Lowland: Arable, Mixed, Pastoral	Loss of storage capacity leading to increased flood risk downstream. Refer to Section 5.2.1.	Damage and loss of natural vegetation and valuable ecosystems. Negative impact on water quality (for example, silt).	Sustainable land management strategies (for example, riparian buffer zones, and adoption of erosion protection measures). Restoration of wetlands and floodplains. Creation of washlands.
	Improvement of upland moors as agricultural land (via drainage)	Upland: Arable, Mixed, Pastoral, Forestry	Increased run-off and erosion as a result of soil degradation and loss of vegetation cover. Refer to Section 5.2.1.	Damage and loss of valuable ecosystems.	Reviewing land drainage. Habitat restoration. Wetland creation. Woodland creation.

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
	Abstraction	Upland: Arable, Mixed, Pastoral Lowland: Arable, Mixed, Pastoral	An issue where large-scale commercial users abstract water. Possible negative effect if land use change is perceived as reducing future abstraction potential. May have slightly positive effect on initial storage capacity of river channel at onset of winter. Refer to Section 5.2.2.	N/a.	Licence conditions. Water trading.
	Land preparation and cropping	Upland: Arable, Mixed Lowland: Arable, Mixed	Unprotected soil; compaction, capping, puddling, plough plans: decreased infiltration capacity leading to increased run-off, erosion and siltation even in gradual slope areas. Refer to Section 5.2.3.	Negative impact on water quality (turbidity) and aquatic ecosystems.	Sustainable land management strategies: integrated farm management, improved soil management (growing cover crops; undersowing grass; crop rotation including grass; minimum tillage; removing compaction; and ensuring surface roughness), and uncropped margins (as in agri-environment proposals).

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
					Regeneration of vegetation/habitat restoration.
	Stocking/grazing	Upland: Mixed, Pastoral	Compaction, capping and puddling: decreased infiltration capacity and interception rates, leading to increased run-off, erosion and siltation. Refer to Section 5.2.4.	Decrease in vegetation cover and diversity. Negative impact on water quality (turbidity) and aquatic ecosystems.	Sustainable land management strategies: improved livestock management (move livestock regularly, and decrease stocking rates), and improved soil management. Habitat restoration/creation. Reviewing system of land drainage.
		River and streambanks Upland: Mixed, Pastoral Lowland: Mixed, Pastoral	Erosion and siltation as a result of damage to riverbanks. Refer to Section 5.2.4.	Loss of streamside trees, damage to riparian habitat. Negative impact on water quality (turbidity) and aquatic ecosystems.	Sustainable land management strategies: improved livestock management (decrease stocking rates, and keep livestock away from sensitive areas), and establish riparian buffer zones.
	Loss of on-farm storage	Upland: Arable, Mixed, Pastoral, Forestry Lowland: Arable, Mixed,	Increase in peak flows due to loss of barriers that would contain flow. Refer to Section 5.2.5.	Damage and loss of valuable ecosystems.	Creation of on-farm storage (for example storage ponds, and constructed wetlands).

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
		Pastoral, Forestry			
	Loss of floodplain area	Lowland: Arable, Mixed, Pastoral, Forestry	Increase in run-off and decrease in time to peak. Refer to Section 5.2.6.	Damage and loss of valuable ecosystems. Negative impact on water quality (turbidity) and aquatic ecosystems. Reduced potential for recreation.	Creation of washlands (frequently flooded or rarely flooded).
	Loss of riparian zones	Upland: Arable, Mixed, Pastoral, Forestry Lowland: Arable, Mixed, Pastoral, Forestry	Increase in run-off and decrease in time to peak. Refer to Section 5.2.7.	Damage and loss of valuable ecosystems. Negative impact on water quality (turbidity) and aquatic ecosystems. Reduced potential for recreation.	Re-construction of the riparian zone.
FORESTRY	Tree-felling	Clear felling Upland: Forestry Lowland: Forestry	As size of clear-fell areas become larger, run-off and peak flow increase and more water course sedimentation occurs. Poorly managed harvesting operations may result in run-off, and blocking and contamination of water courses. Refer to Section 5.3.1.	Felling large areas can appear visually unattractive. Biodiversity impacts can be both positive and negative.	Make size of clear-felled areas as small as possible or move to continuous cover forestry where site conditions allow. The latter can result in reduced peak flow, less run-off due to increased infiltration, intercepted precipitation, evapotranspiration and litter build-up.

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
					Ensure planning of harvesting operation adheres to “Forest and Water Guidelines” and has Forestry Commission Felling Licence/WGS approval. Ensure tree harvesting operations are planned and managed to meet best practice standards to minimise watercourse impact.
	Drainage in existing woodlands	Upland: Forestry Lowland: Forestry	Slightly increased peaking rate and flow for a short while after operation completed. Impact depends on scale of operation. Refer to Section 5.3.2.	May cause downstream impacts for a short time.	Minimise drainage as far as possible and undertake work in accordance with “Forest and Water Guidelines”. Re-site old drains where inappropriate.
	Re-stocking felled areas	Upland: Forestry Lowland: Forestry	Impacts will increase with scale of operations. Initially increase in peaking rate and flow; negative impact declines gradually with canopy closure [15-20 years].	The use of only one, or a few, species may be less attractive visually and may reduce biodiversity potential of site.	Size determined by clear-felling area. Introduce as much diversity as possible of appropriate tree species. Ensure restocking meets “Forest and Water Guidelines”

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
			The use of a single species, or a few, may result in greater negative impact than a more diverse use of species over the long-term. Refer to Section 5.3.3.		Encourage species that give good ground cover. Minimise physical site drainage preparation operations as far as possible. Reduce use of herbicides in re-stocking so ground cover is maintained.
	Woodland creation	Upland: Arable, Mixed, Pastoral, Forestry Lowland: Arable, Mixed, Pastoral, Forestry	The impact of site preparation and drainage prior to planting on peak flow and run-off will increase with scale; negative impact declines gradually with canopy closure [15-20 years]. Refer to Section 5.3.4.	The use of a single species, particularly if coniferous, can reduce biodiversity and potentially, later, physical diversity of woodland structure. May be less attractive visually. Will result in carbon fixing.	As far as possible, minimise ploughing and ditching, and remove direct drainage connectivity to natural water courses. All work should adhere to "Forest and Water Guidelines". Reduce herbicide use. Maximise diversity of species where possible.
	Woodland type	Native and semi-natural Upland: Arable, Mixed, Pastoral	Reduce flood risk and extent as there is normally good structure and diversity of species. New native woodlands are less	Contribute significantly to biodiversity, wildlife and recreation.	Protect existing ones. Encourage spread of species, especially by natural regeneration of thin strips.

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
		Lowland: Arable, Mixed, Pastoral	effective than existing woods. Refer to Section 5.3.5.		
		Broadleaves Upland: Forestry Lowland: Forestry	Impact dependent on woodland structure. Least effective in autumn and winter in controlling peaking rate and flows when not in leaf. New woods are less effective than older ones. Presence of ground vegetation could be an important factor and is likely to be higher than under conifers. Refer to Section 5.3.5.	Younger woodlands may contribute less biodiversity, and appear less visually attractive than older well established broadleaved woodlands. Can be valued for recreation and carbon fixing.	Diversify age and physical structure of wood wherever possible and appropriate.
		Coniferous Upland: Forestry Lowland: Forestry	Uniformity of structure and use of limited number of species can result in increased peaking rate and flow, negative impact declines gradually to nil with canopy closure [15-20 years]. Impacts will re-occur when, and if, trees are clear felled (see	May be considered less visually attractive in some situations depending on location and scale. May contribute to biodiversity, recreation and carbon fixing.	Diversify age and physical structure of woods wherever possible.

Land Use	Practice	Land Uses	Potential Impact on Flood Risk and Extent	Additional Impacts (for example, Recreation and Biodiversity etc.)	Opportunities for Change
			above). May scavenge more particulates from air in upland areas (all year round foliage) and reduce water quality. Refer to Section 5.3.5.		
NATURE CONSERVATION	Water management for wetlands	Upland: Arable, Mixed, Pastoral, Forestry Lowland: Arable, Mixed, Pastoral, Forestry	Natural habitats are not all suited to use for (temporary storage) or as floodplain (for example the higher the water level, the less flood storage available). Refer to Section 5.4.1.	Objectives for reducing the risk and extent of flooding may conflict with those of nature conservation.	Creation/restoration of wetlands.
	Sites affected by uncontrolled burning	All conservation sites managed by burning	Damage to soil structure resulting in reduced infiltration and accelerated run-off. Refer to Section 5.4.2.	Damage and loss of valuable ecosystems.	Adherence to sustainable land management strategies. Bracken composting. Habitat restoration.

Practices listed in column 2 refer to present day practices rather than historical ones.
Erosion: decreases water quality, increases siltation leading to in-filling of reservoirs and ponds, and reduces storage capacity in the water system.
Infiltration: allows the soil to act as a storage area, decreasing run-off and lowering the peak flow.

As detailed in Section 5.1, the soil is the first line of defence in flood management. Intensive agriculture can (accelerate) changes to soil structure by: mixing soil horizons, compacting the sub-soil, puddling[4] the soil surface and increasing the rate of loss of organic matter (Environment Agency[a], Undated). Damage can lead to decreased storage, and increased risk of run-off and flooding even on shallow slopes (Hollis and Thompson, 2003). For example, during the winter 2000 floods it was claimed that catchments such as the Severn, Yorkshire Ouse and Medway were flooded because they were saturated by the first storms, and were unable to absorb more rainfall. However, inspection by the Soil Survey and Land Research Centre in the Severn and Ouse suggested that land management had affected in-field run-off (Royal Society for the Protection of Birds, 2001).

Land drainage practices alter the natural soil water regime (Hollis and Thompson, 2003). The subsequent conversion of upper and lower catchment natural habitats to agricultural land has decreased the storage capacity, leading to a range of direct and indirect environmental impacts.

Table 5.2 below summarises the key agricultural land uses, land management practices and mitigation measures identified as being relevant to this study, and their expected potential overall impact on flood risk and extent, based on the information available. Refer to Table 5.1 for a complete overview of the land uses and land management practices, potential impacts on flood risk and extent, additional impacts, and opportunities for change in relation to each practice.

Table 5.2 - Agricultural Land Uses and Land Management Practices/Mitigation Measures, and Their Potential Impact on Flood Risk and Extent

Practice/Mitigation Measure	Potential Impact on Flood Risk and Extent
Drainage and water level management	-/+
Abstraction	?/-
Stocking/grazing	
- Uplands	-
- River- and stream banks	-
Land preparation and cropping	?/-
On-farm storage	
- Storage ponds	+
- Constructed wetlands	+
Washlands	
- Frequently flooded	+
- Rarely flooded	+
Floodplain restoration	+
Riparian zones	+
Sustainable land management strategies	+

- a potentially exacerbating effect

+ a potentially mitigating effect

? unknown effect/no evidence

[4]The smearing or smudging of the soil surface which reduces its permeability

The following sections describe these agricultural practices and mitigation measures in more detail, with the exception of sustainable land management strategies (refer to Section 5.5).

5.2.1 Drainage and Water Level Management

The hydrological impact of land drainage varies both spatially and temporally depending on local factors such as:

- Soil wetness regime;
- Storage capacity (being dependent upon parameters including soil texture and soil structure);
- Standard of drain and ditch maintenance; and
- Frequency of drain and ditch maintenance.

(O'Connell *et al*., 2003).

Clayey soil has little potential for storage, which leads to a rapid response to rainfall. In this context, drainage tends to reduce the percentage of run-off and increase the time to peak (Hollis and Thompson, 2003). In contrast, the drainage of other soil, with larger storage capacities, tends to increase peak flows.

The magnitude and direction of the change in flows due to drainage can differ between the field and catchment -scales as a result of:

- **Dilution effects**. Not all agricultural land is drained due to physical and socio-economic factors.

- **Distribution effects**. The specific location of drains will affect the hydrological response in a catchment, as the travel times from different parts of a catchment will vary.

- **Deterioration of the drainage effect**. A drainage system is most effective when it is first installed. Many drainage systems were installed during the 1950s; grant-aid increased this during the 1970s, however grant aid ceased in 1983. While only drains installed during the last 40-50 years have the potential to deliver effective drainage under modern agriculture, some deeper drains (for water table control) may remain effective after 200 years.

- **Channel routing effect**. Improvements to streams and rivers, such as dredging and removal of vegetation, shorten travel times and reduce catchment storage.

In general, catchment studies do not have good information on the amount, location and timing of drainage works.

(O'Connell *et al*., 2003).

Subtle changes to water management regimes, such as lowering the water table in late spring or early summer, can have major impacts upon nature conservation interests.

Use of lowland floodplains as agricultural land (via drainage)
The conversion of floodplain to agricultural land reduces the potential storage capacity due to the embankments/pumping built to prevent over bank flooding. In many cases, this practice has also removed characteristic habitats such as open water, wet grassland, wet woodland and reedbeds. Wading birds continue to decline, for example snipe are almost entirely restricted to nature reserves (Royal Society for the Protection of Birds, 2001).

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
				X	X	X	

Opportunities/barriers to change:

- Reviewing system of land drainage;
- Adopting erosion protection measures and sustainable land management strategies (refer to Section 5.5);
- Vegetating ditch banks;
- Washland creation/floodplain restoration (Section 5.2.6), eventually with native woodland/wetland vegetation and low density grazing; and
- Re-constructing the riparian zone (Section 5.2.7).

Many drains in agricultural areas are generally drained dry in the winter. Instead, they could be used to store water for use in dry summers. This would reduce the pressure on water allocation, and facilitate the conservation of wet habitats such as wetlands.

Improvement of upland moors as agricultural land (via drainage)
In this context, the term upland moor is used to refer to land, which supports dwarf-shrub heaths, mires, scrub, grassland and woodland i.e. semi-natural vegetation. To increase production, some areas of upland moors in England and Wales have been converted to improved pasture or arable land via drainage or moor gripping (grips are

open channels cut through the peat). However, most of the restoration of uplands to agriculture has been to improved grassland pastures rather than arable cultivation, because arable crops are marginal under the altitude/climatic regime. There may be some root crops grown for animal feed, in which case, there is the initial re-seeding operation where the land would lie bare for a short period.

The drainage of upland systems can impact on two important stages of the rainfall-run-off response: the partition of incoming precipitation into rapid run-off, soil moisture storage evaporation and slower run-off processes; and the routing of the resulting rapid run-off through various flow pathways to rivers (Gilman, 2002).

The loss of habitat to land in production has implications for flood risk and extent, as well as nature conservation and the wider environment (for example enhanced greenhouse gas emissions). The change in land use goes paired with decreased vegetation coverage, in the case of arable land use, in addition to the (potential) negative impacts associated with agricultural use. Increased erosion due to livestock or arable production increases flood risk and extent because of the loss of storage capacity within watercourses, and infilling of reservoirs and ponds due to siltation. The net impact is increased run-off and peak flows. Stocking is discussed in more detail in Section 5.2.4.

The ecological effects of moor gripping also include the direct loss of flora and fauna as a result of the reduction in habitat. Further damage has been caused to important bog - moss (*Sphagnum*) communities through damage to the hydrological integrity of the peat. Habitat fragmentation, resulting from the partial conversion of continuous habitat, can lead to the loss of species and habitats, and increase the vulnerability of ecosystems to climate change (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X	X				

Opportunities/barriers to change:

- Reviewing system of land drainage;
- Adopting erosion protection measures and sustainable land management strategies (refer to Section 5.5);
- Habitat restoration;
- Wetland creation (Section 5.2.7); and
- Woodland creation (Section 5.3.4).

On the Raby Estate in Teesdale, English Nature worked with landowners and farmers to restore a more natural drainage pattern by funding works to block grips (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

5.2.2 Abstraction

Following the publication of “Taking Water Responsibly”, the government's proposals for reviewing the abstraction licensing system in England and Wales, the Environment

Agency was instructed to use its powers to revoke unsustainable abstraction, where abstraction is the cause of environmental problems (www.environment-agency.gov.uk). Sustainable abstraction is relevant to this study in terms of a catchment-based approach to land and water management.

Unsustainable abstractions are more frequently those licensed to take water during the summer. These abstractions cause river flows to fall to levels generally viewed as being damaging to the environment when there is insufficient water for both environmentally acceptable flows and the abstraction (www.environment-agency.gov.uk). This has major implications for wildlife.

In general, the authors do not consider that abstraction would influence flood risk to any great extent. However, the issue is of significance where there are large-scale commercial users of water discharging to rivers already carrying large volumes of water.

Abstraction may have a slightly positive effect on the initial storage capacity of the river channel at the onset of winter.

If there was a greater area of woodlands established to potentially reduce flood risk and extent, this could in due course, reduce the quantity of water available for abstraction depending on the scale and nature of the woodlands created, and may therefore be unacceptable. However, any reduction in the quantity of water abstracted for other uses would reduce this potential for conflict and might allow more woodlands to be established.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X		X	X	X	

Opportunities/barriers to change:

- Reviewing existing licensing arrangements for large volume abstractions/discharges (i.e. timing and/or quantities); and
- Proposed trading of water may help to alleviate flood risk and extent (for example by creating storage capacity in areas of high flood risk).

5.2.3 Land Preparation and Cropping

Arable land management and farming practices have changed significantly over the past 50 years throughout England, Wales and Scotland reflecting advances in knowledge and technology, competitive business and market environment. Many of these shifts have impacted upon water resources and cycles, and thus both directly and indirectly upon flood risk and extent.

The main land management changes of relevance to flood policy and prevention can be summarised as:

- The increase in both average farm size and average field size driven principally by the substitution of labour by capital equipment;

- The move away from mixed agriculture (producing both stock and crops) to more specialised systems, and the consequent decline in on-farm organic matter for soil nourishment;
- Changes to crop rotations and the timing of crops; and
- The loss of on-farm water storage systems and features such as ponds.

Arable land management (such as untimely operations on susceptible soils and some tillage practices) can lead to soil compaction, puddling, capping on light soils, and plough pans. For example, frequent ploughing of upland soils, especially in wet conditions, can result in compaction, exposure and potential erosion of the soil surface, and eluviation that will tend to enhance the plough pan (Environment Agency[a], Undated). Capping and the development of plough pans are described below.

Capping results from the impact of rain droplets on a bare soil surface re-arranging the particles (i.e. affecting the particle size distribution) to give a thin, hard crust on drying out. This can restrict seedling emergence.

Plough pans are discrete layers formed where equipment has exerted a well-defined localised pressure on the soil (National Soil Resources Institute, 2001).

These effects can be compounded by the loss of soil organic matter; a trend that has become increasingly recognised. *"In conventional arable agriculture…the sole reliance on mineral fertilisers or infrequent use of manure has in some areas resulted in a reduction in soil organic matter content, structural stability, earthworm and microbial activity"* (National Soil Resources Institute, 2001). Estimates suggest that 0.5% of soil organic carbon was lost from arable topsoils in England between 1980 and 1995 (Defra, 2003b).

Some crops are high risk because they involve the use of specialist machinery or methods of production, for example contract farming of potatoes, and later harvesting, which increase the risk of compaction and run-off. 'Risky' crops include potatoes and sugar beet (on certain soil types), row crops (such as maize) and modern dwarf orchards. In the case of row crops and orchards, enhanced flood risk may arise due to reduced cultivation (with high weed control leading to much bare ground) and low planting densities. However, any risk needs to be considered within the context of previous land use/s.

Burning may be carried out for game management and/or nature conservation on some farms and estates. This practice is discussed in Section 5.4.2.

As detailed in Section 5.1, soils represent an important water reservoir. The following effects, detailed in Gilman (2002), are important:

- For uncompacted soils, deep-rooted plants tend to reduce rapid run-off by drawing heavily on soil moisture, creating a large soil moisture deficit that must be satisfied by infiltration before widespread surface run-off or shallow run-off can occur; and
- By intercepting rainfall on the canopy, trees and shrubby plants reduce the proportion of moisture reaching the ground and thereby (potential) run-off.

Structural damage therefore results in decreased infiltration; decreased water storage in the soil; and potentially increased run-off, erosion and peak flow rates. Local conditions

are important, as there are spatial variations in soil texture and soil structure. The loss of the water retention capability of soils is often accompanied by increased leaching of chemical fertilisers and natural soil chemicals into watercourses. This has sometimes resulted in an increased requirement for fertilisers to ensure that crops receive the nutrients that they require.

The wider environmental effects of damage to soil structure resulting from land preparation and cropping mirror those caused by grazing-induced erosion occurring on grassland and areas of rough or hill grazing, which are discussed in Section 5.2.4.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X			X	X		

Opportunities/barriers to change:

- Raising awareness of sustainable land management strategies (refer to Section 5.5);
- Regeneration of vegetation/habitat restoration (for example native woodland and other vegetation) in hotspot areas;
- Selecting earlier cropping varieties (thereby reducing bare ground);
- Encouraging organic farming;
- Regulation (such as restricting crop types); and
- Reversion (preferably permanent in high risk areas) to semi-natural vegetation.

Reversion implies taking an area of land out of, most if not all, production. It increases the potential for infiltration due to the development of a mulch or litter layer. The reduction in drainage density and the increase in interception of precipitation by heather and scrub for example, can decrease total run-off and slow down its passage. In closely grazed grasslands, the relatively small storage capacity of the litter layer is probably negligible when compared to a typical storm rainfall, although the gains derived from restoring large areas (such as blanket mire) would be considerable (Gilman, 2002).

5.2.4 Stocking/Grazing

In some locations, the intensification of grazing and supplementary feeding have led to higher stocking densities and a longer grazing season. Between 1971 and 2000, sheep numbers in Wales increased by 85%, with 80% of this rise occurring between 1971 and 1990 (Welsh Assembly Government, 2002).

Grazing can reduce the interception rate and infiltration capacity, whilst increasing flood risk and extent, as a result of changes in vegetation coverage and soil compaction by grazers. Winter grazing can be particularly damaging, as the grazed vegetation is more susceptible to extreme climatic conditions (APEM, Undated). There may also be a degradation of natural soil fertility as a result of centuries of grazing and livestock removals, although these may be partially replenished by fertilisers (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

Grazing can be a major cause of soil erosion in the uplands (APEM, Undated). This can result from the direct effects of grazing, or the associated trampling forming tracks.

Grazing has also been cited for the loss of streamside trees and collapse of gravel banks in the uplands, and damage to riverbanks in floodplains where grazing occurs up to the river's edge (Gilman, 2002; and Summers, 1994). The riverbanks lose their natural variation, the soil structure is damaged, and in extreme cases, bank vegetation disappears. The net result is increased erosion, decreased vegetation and habitat for wildlife, and potentially negative impacts on flood risk and water quality downstream. In addition to increasing flood risk and extent, grazing can reduce the quantity of more palatable plant species, whilst increasing the frequency of less palatable and more grazing and/or trampling resistant species (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

Grazing may therefore be inappropriate in certain circumstances such as geographical locations and under specific management regimes (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002). Identifying and maintaining optimal grazing in terms of both stock density and type can be a difficult balance to achieve. Financial incentives are necessary to attain required levels, for example through English Nature's Wildlife Enhancement Scheme, and Tir Gofal in Wales.

The effects of grazing depend upon a number of factors such as:

- The types and condition of vegetation;
- The type of grazing animal (species and breed);
- The timing and intensity of grazing; and
- Other management practices conducted (for example burning, cutting and bracken management).

Sheep are more selective grazers than cattle, although less so than rabbits. Continental cattle breeds will graze different vegetation to traditional breeds, such as blue-greys in

Northumberland, which is less beneficial to the overall vegetation structure (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

Some livestock enterprises are high risk because they involve the use of specialist methods of production, for example contract farming of outdoor pigs, with greater risk of soil compaction and run-off. However, any risk needs to be considered within the context of previous land use/s.

In the case of upland farming, there are fewer shepherds than in the past, which causes 'hot spots' of grazing pressure and impacts from hooves. APEM (Undated) states that pre-war ratios of shepherds to sheep were 1:2-300 however, the current ratio can be 1:12-1500.

The incursion of livestock into forests and woodland causes browsing damage to trees, with fencing required to prevent this taking place. The forest edge habitat is also less diverse as a result of high density grazing than would be the case with lower grazing intensity on adjacent land (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002). On the other hand, low-density grazing can actually benefit species diversity in woodland forests, and wood-pastures can be valuable habitat for nature conservation.

Grazing also has the potential to exacerbate damage to archaeology and heritage features.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
	X	X			X	X	

Opportunities/barriers to change:

- Applying sustainable land management strategies in pastoral grazing areas (for example moving livestock regularly, decreasing stocking rates, improving soil management);
- Applying sustainable land management strategies in the riparian zone (for example decreasing stocking rates, keeping livestock away from sensitive areas, adopting erosion protection measures);
- Regeneration of vegetation/habitat restoration (for example native woodland and other vegetation) in hotspot areas;
- Selecting the most appropriate grasses and legumes;
- Re-establishing effective shepherding (for example English Nature's Sheep and Wildlife Enhancement Scheme);
- Encouraging organic farming;
- Reversion to semi-natural vegetation; and
- Establishing riparian zones (Section 5.2.7).

5.2.5 On-farm Storage

Agricultural intensification has removed many barriers/buffers that would contain/slow flow in the landscape. For example, since 1945 a 50% reduction in hedgerows has

been recorded (Robinson and Sutherland, 2002 cited in O'Connell *et al*., 2004). However, some of these are now subject to regulation under Environmental Impact Assessment legislation (refer to Section 4.3.7).

The establishment of designated storage areas on agricultural land in a catchment can help floodplain watercourses to 'assimilate' run-off during flood events by reducing peak flows (Land Use Consultants, 2001). However, it is important that storage areas reduce the flood peak (Richardson, 2003).

Storage ponds/constructed wetlands could be combined with in-field storage to reduce flood risk and extent, although one potential disadvantage for landholders is that land may be taken out of production in the former case. Storage ponds and constructed wetlands are described below.

Storage ponds
Under the simplest scenario, a storage pond would temporarily store floodwater, releasing it a few days after the peak flow had subsided. This scenario has a low potential for increasing biodiversity, although might, with careful management, provide benefits for summer irrigation. However, with careful selection and management of the location, there is the potential to achieve a balance between storage availability and biodiversity.

Constructed wetlands
An alternative scenario is a constructed wetland. Natural and constructed wetlands (including wet woodland) provide a range of benefits such as storing water, reducing flood peaks, providing valuable habitat and benefiting water quality. The conservation of existing wetlands and the creation of new wetlands thus address both the loss of wetland habitat and the potential for improved flood mitigation. In a paper on "Wetlands, Land Use Change and Flood Management" (2003), Defra *et al*. agree that there is a good case for *"seeking to address both the loss of wetland habitat and the potential for improved flood mitigation"* via the establishment of wetlands and washlands. Washlands are discussed in Section 5.2.6.

In addition, wetlands benefit water quality by trapping sediments and removing nutrients. They generally remain effective in removing nitrogen as long as the soil remains wet to promote denitrification, and the water table is allowed to fluctuate (Posford Haskoning and the Centre for Ecology and Hydrology, 2003). Water table fluctuation promotes the development of vegetation, and prevents stagnation leading to methane and sulphur release from the sediments. However, in certain situations with archaeological interest this fluctuation would need to be minimised i.e. a static high water table maintained. Wetlands may become sources of phosphorus when anaerobic sediment conditions, leading to the release of bound phosphorus, occur (Posford Haskoning and the Centre for Ecology and Hydrology, 2003).

In the Netherlands, created wetlands are often combined with water storage, recreational use and water quality improvement.

The effectiveness of constructed wetlands for reducing flood risk and extent needs to be investigated further, although, based on available research and evaluation of their physical features, they are expected to have potential benefits for flood control (Defra *et al*., 2003). The specific capacity is dependent on the design and location of the wetland.

Measures such as removing/not maintaining underdrainage systems, restoring ditches, reducing stocking levels, and restoring arable land to rough pasture will promote the establishment of wetlands in locations where they are sustainable (Thorne, 2003; and Defra *et al*., 2003). However, any changes to underdrainage systems need to be balanced against flood risk.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X	X	X	X	X	X

Opportunities/barriers to change:

- Increased storage;
- Enhanced water quality;
- Increased biodiversity;
- Potential wider public benefits including recreation;
- Potential benefits for water management (for example maintaining water levels in times of water shortage);
- Requires suitable design and management strategy;
- Location must be strategically chosen for (optimum) effect; and
- Potential modification or sacrifice of current land use.

5.2.6 Washlands

A washland is typically an area of floodplain surrounded by banks that provides a low level of flood protection. In a flood event higher than the inlet threshold, the floodplain fills with water and provides capacity for both (temporary) storage of flood water and flow (Richardson, 2003; and Defra *et al*., 2003). Depending on the design, washlands can be combined with a number of different land uses including pastoral grazing, cropping, biomass crops (reed, willows), woodland and wetland creation or restoration.

As detailed in Section 1.1, floodplain restoration (including the (re)creation of washlands) can reduce flood risk and extent, whilst delivering a more sustainable approach to flood management. For example, computer modelling of the River Cherwell in Oxfordshire (between Oxford and Banbury) showed that embanking the river increases the peak flows downstream by up to 150%. In contrast, restoring the river channel through the floodplain reduces the peak flow by approximately 10-15 % and increases peak water levels within the floodplain by 0.5-1.6 m (Acreman, 2003). Studies have shown that catchments with 15% of wetlands can reduce flood peaks downstream by 90%. The first 5% of the wetlands account for 50% of this reduction (Royal Society for the Protection of Birds, 2001).

Currently, there is insufficient evidence to ‘guarantee’ the effectiveness of the natural environment to reduce flood risk and extent, although based on the concept of most stable natural environments offering physical features which reduce flood risk and extent, the re/-establishment of floodplains will improve flood management (Richardson, 2003; and Defra *et al*., 2003).

Changes in land use or attitudes in an area currently protected by flood banks and walls can offer the opportunity for re-instating or creating a washland to increase flow area, potentially decreasing the risk and extent of flooding downstream. The degree of benefit derived will vary per situation depending on the proximity of risk areas upstream, the river gradient, the additional flow area obtained (Richardson, 2003; and Defra *et al*., 2003) and the design of the washland. However, where good quality agricultural land is in short supply, such as in many parts of Wales, there may be significant barriers to taking this out of production to create washlands.

An evaluation of the flow of floods across floodplains is essential to determine if obstructions, such as bridges and roads, are present and need to be altered (Richardson, 2003; and Defra *et al*., 2003).

Morris *et al*. (2003) have produced a classification of washlands in terms of:

- Flood regime;
- Washland soil wetness (following the cessation of flooding); and
- Land use and related habitats.

This enables the potential for biodiversity to be determined, as well as a range of actions that can optimise flood management objectives and habitat value. Five case studies in England and four in Europe were used to validate the typology. The English case studies showed that there is limited evidence of the integration of flood management and biodiversity objectives. It was concluded that the best overall results are achieved where washland sites are designed with biodiversity objectives from the outset, by manipulating the flooding and wetness regime to suit both flood management and biodiversity.

Four washland 'types' are discussed below: rarely flooded washlands, frequently flooded washlands, washlands with wetlands, and washlands with woodlands.

Rarely flooded washlands
In the case of rarely flooded washlands, landowners are able to continue intensive farming. This option delivers flood benefit, although provides limited nature conservation benefits (Royal Society for the Protection of Birds, 2001) or wider public benefits such as recreation.

Frequently flooded washlands
Frequently flooded washlands are able to incorporate (semi)natural habitats (such as wet grassland, woodlands and wetlands), thereby enhancing the biodiversity of the area, as well as providing additional benefits to water quality and recreation. There are a number of multi-purpose washlands in operation, for example the Nene Washes (Royal Society for the Protection of Birds, 2001). These store floodwater in times of heavy rainfall, but are also used for extensive grazing, and are under a hydrological management regime that 'delivers' wet grassland well suited for breeding and wintering birds.

Washlands with wetlands
Wetlands can be defined as areas where the water table is either seasonally or permanently high. By storing water and reducing flood peaks, wetlands within washlands, reservoirs or flood by-pass channels can potentially reduce flood risk and

extent downstream. They also allow groundwater recharge in times of plenty (Defra *et al*., 2003). Floodplain wetlands also return the water to the river slowly and therefore, can provide benefits for water management by helping reduce low flows and improving water resource security during times of low rainfall (Defra *et al*., 2003; and Royal Society for the Protection of Birds, 2001).

When considering the creation of wetlands in existing or new washlands, reservoirs or flood by-pass channels it should be borne in mind that maintaining a high water table reduces the subsurface water storage available (Defra *et al*., 2003). The creation of wetlands in such areas thus limits the potential benefits in reducing flood risk and extent. The frequency and depth of flooding, the amount of water level fluctuation that can be tolerated by the (desired) wetland habitat, and the quality of the incoming water should be considered.

To optimise additional storage, the location and design should be based on an assessment of flood volumes and flow capacities at critical risk areas on the river system in relation to peak flows (Defra *et al*., 2003).

Washlands with woodlands
Woodlands can help to tackle soil compaction due to 'inappropriate' stocking densities or poor land management thereby improving soil structure, organic matter levels and infiltration rates (Nisbet, 2003). In addition, a well-developed floodplain forest, composed of a mixture of forest, open water and marshland, provides habitat for a wide range of wildlife species. The forests may form corridors by which woodland species can move through the landscape. However when considering the design of the floodplain, it is essential to ensure that the woodland will not significantly reduce summer low flows and water supplies downstream (Nisbet, 2003) or act as a barrier to non-woodland species. This might be achieved by ensuring that there is a low density of tree cover.

Constraints to the restoration of floodplain woodlands are the need to conserve important open wetland habitats, maintain access to the main river, protect buried archaeology and maintain a navigable channel for boat traffic. Assessing these aspects would almost certainly form part of an Environmental Impact Assessment. In addition, the resource costs are an issue and in Wales, there is a scarcity of available land.

Establishing new floodplain forests or woods, on any scale, could potentially increase flood levels locally due to flow path intervention and blockage from standing trees and brush which might lead to 'dam break' situations if the woodlands were not properly managed. This situation could be avoided if a low density forest cover was established. Also, by setting new woodland back from the main channel so that there is space for maintenance work to be undertaken. The storage generated through establishing this type of woodland might reduce flood risk and extent. Another indirect benefit, once the woodland was established, would be the prevention of future negative built developments.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
				X	X	X	X

Opportunities/barriers to change:

- Increased storage;
- Direct flood defence money to farmers as a small capital payment is usually required to establish wetlands;
- Lack of funding available for ongoing management;
- Difficult to include the value of biodiversity in the Benefit: Cost Analysis appraisal of flood defence schemes;
- Providing technical advice and eventual compensation to farmers for establishing wetlands;
- Enhanced water quality;
- Increased biodiversity;
- Wider public benefits including recreation, health and mental wellbeing (through 'green gym' and health walks), and education;
- Potential benefits for water management (for example maintaining water levels in times of water shortage);
- Requires suitable design and management strategy;
- Location must be strategically chosen for (optimum) effect;
- Sustainable wetland creation requires consideration of long-term water resource issues;
- Land managers' attitudes; and
- Potential modification or sacrifice of current land use.

5.2.7 Riparian Zones

Riparian zones can range from simple streambank vegetation, such as reedbeds, to more extensive riparian wetlands and woodlands. Woody debris dams can retain and slow down floodwaters. They can potentially reduce flood risk and extent by allowing rivers to expand and contract in response to increases in flow. In most cases because they are small, they are expected to have a neutral impact on storage (Defra *et al*., 2003). However, in Bear Brook, Buckinghamshire, the flood storage capacity area was enhanced for wildlife by creating a low level wetland consisting of permanent ponds, seasonal pools and scrapes. With respect to the Great and Long Eau, Lincolnshire, flood banks were set back and a variety of wetland and river features were created (Royal Society for the Protection of Birds, 2001).

The (re-construction of the) riparian zone can include a wide range of additional benefits including:

- Enhancing bank protection;
- Benefiting river purification by minimising the impacts of nitrate and pesticide leaching from agricultural land (Posford Haskoning and the Centre for Ecology and Hydrology, 2003);
- Reducing sediment loading of the water system;
- Increasing the species richness of an area by providing habitat for a range of flora and fauna;
- Increasing the aesthetic and recreational value of an area;
- Enhancing fisheries by providing shading and shoreline habitat; and
- Serving as a corridor between larger habitat areas and hence, facilitating movement between isolated areas.

The (re)establishment of riparian zones will potentially require modification or the sacrifice of current land use in the riparian zone, such as intensive arable farming, and might be limited by river engineering and flood protection (Defra *et al*., 2003).

Riparian zones are also relevant in the uplands, particularly with respect to debris dams delaying flows.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X	X	X	X	X	X

Opportunities/barriers to change:

- Potential modification or sacrifice of current land use;
- Providing technical advice and eventual compensation to farmers for establishing riparian zones;
- Enhanced biodiversity;
- Improvement in water quality; and
- Introducing guidelines to protect riparian zones.

5.3 Forestry

General Description

Afforestation and deforestation have been studied extensively to assess their impacts on the hydrology of catchments, although much of the experimental research has been undertaken in small catchments (<10km^2) and the transfer of these results to larger scales is challenging (O'Connell, 2003).

The conversion of open land to forest can have significant effects on the water budget, although its impact on the flood regime is less obvious. Conifer afforestation has been linked to increased and accelerated run-off, and localised impacts such as erosion and sedimentation (Gilman, 2002). While these may have occurred in the past, since the early 1990s, there have been a number of changes in forest practices to minimise their environmental impacts. For example, the adoption of the best practice detailed in the "Forest and Water Guidelines" (2004).

The effectiveness of woodlands in reducing flood risk and extent depends on the tree type, the developmental state of the trees (young or mature) and the type of ground cover. For example, woodlands comprising (partially) deciduous trees will have a lower effectiveness in the winter because the canopy will not contribute significantly to interception of rainfall, and evapotranspiration will be negligible (Babtie Group and Renfrewshire Council, Undated).

Table 5.3 below summarises the forestry practices and mitigation measures identified as being relevant to this study, and their expected potential overall impact on flood risk and extent, based on the information available. Refer to Table 5.1 for a complete overview of the forestry practices, potential impacts on flood risk and extent, additional impacts, and opportunities for change in relation to each practice.

Table 5.3 - Forestry Practices/Mitigation Measures, and Their Potential Impact on Flood Risk and Extent

Practice/Mitigation Measure	Potential Impact on Flood Risk and Extent
Tree-felling	-
Re-stocking felled areas	+
Woodland creation	+
Woodland type - Broadleaves	+
- Conifers	+
Drainage in existing woodlands	*neg*.

+ a potentially mitigating effect

- a potentially exacerbating effect

neg. a potentially negligible effect

The following sections describe these forestry practices and mitigation measures in more detail, with the exception of sustainable land management strategies (refer to Section 5.5).

5.3.1 Tree-felling

In general, the removal of large areas of woodland can be expected to increase run-off and erosion, because more water reaches the ground and evapotranspiration no longer takes place (Gilman, 2002). The method of removal affects the extent of these impacts, as does the catchment, although these are by no means inevitable consequences if good practice is followed.

Large areas of clear-felling, which were common practice with commercial coniferous forest management approximately 10 or more years ago, can have serious hydrological and environmental impacts. At a headwater scale, tree removal has been shown to negatively affect run-off, groundwater levels and peak discharge levels. In particular, deforested areas have shown an immediate increase in groundwater levels and total run-off because more water reaches the ground rather than being intercepted by the canopy. The magnitude of the effect of tree-felling on flood risk and extent can vary per catchment. In an experimental catchment in Coweeta, North Carolina, clear-felling increased run-off by 11% and peak flows by 7%. At Jamison Creek, British Columbia, tree-felling led to a 13% increase in winter peak discharges (Coulthard and Jones, 2002). The removal of a tree canopy allows more rainfall erosion following clear-felling; while the creation of disturbed or bare ground, and the construction and use of access roads, allows more erosion during subsequent rainfall events (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002). Soil erosion in turn can result in the loss of organic matter, the sedimentation of rivers, the loss of soil structure and alterations to hydrological regimes.

To ensure that Best Management Practices are employed during tree-felling, the UK Forestry Standard has been introduced. This together with its supporting guidance detailed in the “Forest and Water Guidelines”, should ensure that adverse environmental impacts are minimised. Compliance is mandatory under the various regulatory schemes administered by the Forestry Commission. In addition, management standards may be underpinned by membership of the voluntary UK Woodland Assurance Standard (WAS), which also refers to Forestry Commission guidance such as the “Forest and Water

Guidelines". As a result, tree-felling should have no significant impact now on downstream flood risk and extent under normal rainfall conditions.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
			X				X

Opportunities/barriers to change:

- Meeting the UK Forestry Standard;
- Adhering to the "Forest and Water Guidelines";
- Applying continuous cover forestry where possible;
- Restructuring plantations (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002); and
- Designing riparian zones within forests (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

5.3.2 Drainage in Existing Woodlands

The development of new drains or the cleaning of existing ones in established coniferous woodlands might take place to maintain tree growth and stability. However, the frequency and scale of these operations is unlikely to have any affect on downstream flood risk and extent. The necessity of developing or maintaining drains is less common in broad-leaved woodlands, as these are usually found on better quality soils at lower elevations.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
			X				X

Opportunities/barriers to change:

- Meeting the UK Forestry Standard;
- Adhering to the "Forest and Water Guidelines"; and
- Leaving buffer areas at the end of internal woodland drains.

5.3.3 Re-stocking Felled Areas

Construction of new drains, re-opening of existing ones, or other site preparation work following clear-felling and prior to re-stocking, is likely to result in some increase in run-off and peak discharge levels under normal rainfall patterns, although these are unlikely to have a significant effect on flood risk and extent.

Natural regeneration may involve less soil disturbance than planting. However, whether natural regeneration or re-planting is used to re-stock an area, this is unlikely to have any significant impact on flood risk and extent, given the relatively small sizes of the areas involved in relation to the catchment as a whole.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
			X				X

Opportunities/barriers to change:

- Meeting the UK Forestry Standard;
- Adhering to the "Forest and Water Guidelines";
- Using species mix to increase biodiversity; and
- Minimising drainage work.

5.3.4 Woodland Creation

Woodland creation refers to the establishment of woodland vegetation, either by planting or natural regeneration. The impacts of woodland creation will depend upon the size of the wood and will change over time as the woodlands grow and develop. Most new woodlands now being established are less than approximately 10ha, and predominantly through the conversion of small underused areas of agricultural land. The creation of new native woodlands fits in with the UK's Habitat Action Plan for woodlands.

Drainage and compaction during the initial ground preparation for establishing a new woodland can potentially have strong negative impacts on peak flows, as well as the surrounding environment (such as existing flushes and bogs). However, their influence on flood risk and extent is now very limited in practice because of the small areas involved. Much of the initial establishment work is designed to overcome existing compaction often associated with the previous land use. Mounding may help to decrease run-off and increase soil infiltration. The control of vegetation to allow more rapid initial growth of young trees may be detrimental if undertaken on any scale, as it exposes the soil for a longer period leading to greater risk of run-off.

The construction of new roads, or the upgrading of existing ones, can have a negative impact on water quality and flows, although the scale and pattern of development are important. Any major development of new roads is now subject to an Environmental Impact Assessment, which must be approved by the Forestry Commission England or the Forestry Commission Wales, prior to any work being undertaken (refer to Section 4.3.7). The upgrading of existing roads and tracks should be in accordance with the "Forest and Water Guidelines", which therefore minimises the environmental impacts.

Broadleaved woodlands
Most areas of new broadleaved woodlands that are established in England and Wales are generally small. Deciduous woodland creation will reduce and delay peak flows when compared to more open vegetation types and agricultural land due to the improvement in soil infiltration rates, and through the reversal of soil damage associated with past agricultural activities. In general, the effectiveness of this type of woodland, on an annual basis, is expected to be more varied and smaller than coniferous woodlands or plantations. However, this will depend upon the species mix (Gilman, 2002; and Babtie Group and Renfrewshire Council, Undated).

Coniferous woodlands
Gilman (2002) states that various field data indicate a closed canopy (15-20 years matured) has an effectiveness of 30% decrease of precipitation on an annual basis, and increased infiltration in summer and autumn (no numerical data). The Plynlimon study (involving a comparison of moorland with conifer woodland development), indicates total evaporation rates of 15-17 % from grassland compared with 29-32 % from forestry, although it also shows that these relativities vary significantly during the forest cycle and illustrates the complexity of relationships with stream flow (Welsh Assembly Government, 2003).

Woodland creation should aim to cause minimal disturbance to the ground surface, whilst maintaining as much ground-cover vegetation as possible. Adherence to the "Forest and Water Guidelines", adopted by the Forestry Commission England and Forestry Commission Wales, is a requirement of the Woodland Grant Scheme and UK Woodland Assurance Scheme (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

The advantages and disadvantages of the three general types of forest in England and Wales are discussed in Section 5.3.5 below.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X	X	X	X	X	X

Opportunities/barriers to change:

- Meeting the UK Forestry Standard;
- Adhering to the "Forest and Water Guidelines";
- Loss of agricultural land;
- Increase in biodiversity;
- Maximising variety of species suited to site conditions;

- Wider public benefits including recreation, health and mental wellbeing (through 'green gym' and health walks), and education
- Decreased run-off in longer term; and
- Increased storage capacity in the soil, and delayed peak flow in longer term.

5.3.5 Woodland Type

Semi-natural or 'native' woodlands
The effectiveness of existing native woodland on flood risk and extent depends partially on the structure of the woodland and the species composition. The nature of the ground vegetation will also have an important influence on the speed at which rainfall reaches the soil, and then subsequently enters streams and rivers.

Semi-natural and native woodlands have additional benefits for recreation, wildlife and habitat diversity. This type of woodland is worthy of consideration in sensitive areas where more intensively managed forests may be deemed appropriate. When undertaking native woodland creation, the managers should consider encouraging whole communities of native trees and shrubs appropriate to the site, with the aim of approaching the appearance and ecological integrity of semi-natural woodland (Rodwell and Patterson, 1994). Areas for consideration range from small pockets along streamsides in a forest of conifers to extensive areas comprising a mosaic of woodland, heath and mire in the uplands.

A net gain for nature conservation can be realised by the establishment of new native woodlands in improved pasture areas or arable fields, even if the quality of the forest is 'poor' when compared to historic natural woodlands. The replacement of existing areas of high nature conservation value, such as the rare lowland heaths of southern England should be avoided, because it could result in a net loss of value to society. Woodland establishment on adjacent land may also adversely affect wetland habitats such as fens or raised mires.

Woodlands can be combined with low density grazing, which can be beneficial in maintaining diversity and encouraging germination of trees and shrubs (Rodwell and Patterson, 1994). In newly created sites, it may be best to wait until trees are well established, anything from 5 to 20 years depending on the site.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X		X	X	X	

Opportunities/barriers to change:

- Adhering to the “Forest and Water Guidelines”;
- Increase in biodiversity;
- Wider public benefits including recreation, health and mental wellbeing;
- Decreased run-off; and
- Increased storage capacity in the soil and delayed peak flow.

Broadleaved woodlands
The effectiveness of other broadleaved or predominantly broadleaved woodlands in reducing flood risk and extent is dependent on their age, composition and structure. Older woodlands are generally more effective than recently planted ones, as is the case with those that have a more varied composition and structure, although the impact of younger woods will increase as they mature.

Broadleaved woodlands, whether of native species or not, tend to have less impact in the winter, because the trees are without leaves.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
			X				X

Opportunities/barriers to change:

- Adhering to the “Forest and Water Guidelines”;
- Increase in biodiversity;
- Wider public benefits including recreation, health and mental wellbeing;
- Decreased run-off; and
- Increased storage capacity in the soil and delayed peak flow.

Coniferous woodlands
Coniferous woodlands can be more effective in reducing run-off and peak flows than broadleaved woodlands in winter because of their greater interception of precipitation, although detailed information is not available to quantify the extent. In upland areas, coniferous species can be better suited to site conditions than broadleaved species and therefore, may grow better and become more effective in reducing flood risk and extent, as well as being capable of producing commercial timber.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
			X				X

Opportunities/barriers to change:

- Adhering to the “Forest and Water Guidelines”;
- Increase in biodiversity;

- Wider public benefits including recreation, health and mental wellbeing;
- Decreased run-off;
- Landscape implications in certain areas; and
- Increased storage capacity in the soil and delayed peak flow.

5.4 Nature Conservation

General Description

As detailed in previous sections of this report, it is possible for sustainable land and water management to benefit flood risk and extent, as well as nature conservation. For example, the creation of the Severn Vyrnwy wet washland pilot scheme (refer to Section 5.6.4). Table 5.4 below summarises the nature conservation practices and mitigation measures identified as being relevant to this study, and their expected potential overall impact on flood risk and extent, based on the information available.

Table 5.4 - Nature Conservation Practices/Mitigation Measures and Their Potential Impact on Flood Risk and Extent

Practice/Mitigation Measure	Potential Impact on Flood Risk and Extent
Water management for wetlands	+/ none
'Inappropriate' burning	*neg*.

+ a potentially mitigating effect

neg. a potentially negligible effect

In a nature conservation context, the effects of burning are expected to be negligible as this activity will be 'controlled'.

5.4.1 Water Management for Wetlands

The conservation of (semi)natural habitat can place demands on the surface and ground water quality and quantity. For example, the conservation of wetlands and their unique functioning requires the maintenance of their hydrology, and a minimum water quality (refer to Box 1 below).

Box 1. Conservation of Wetlands

Natural wetlands are precious, diverse environments with unique natural habitat and cultural heritage properties, comprising landscapes such as mires, lakes, rivers and their floodplains, estuaries and coasts (www.english-heritage.org.uk). They occur naturally in river valleys where drainage is impeded by topography or soil structure (permeability), and can be natural or man-made.

The archaeological potential of wetland areas has now been shown to be very high (www.english-heritage.org.uk). The excellent preservation of organic materials within waterlogged deposits preserves much more evidence of the material culture of past societies than that surviving on dry-land sites. Wetlands also contain enormously valuable palaeo-environmental information, which can provide indications of the impact of past climatic changes and human activity on the environment. All of this can be placed within a dated framework providing detailed context for the past, whilst informing research into future environmental change.

Research into "Monuments at Risk in England's Wetlands (MAREW)" commissioned by English Heritage from the University of Exeter shows:

- At least 50% of the original extent of lowland peatland has been lost during the last 50 years;
- An estimated 2,930 wetland monuments have been totally destroyed, and some 10,450 are likely to have suffered damage, desiccation, and partial destruction in the same period;
- The main causes of this widespread destruction are drainage, water abstraction, conversion of pasture into arable, peat wastage, peat erosion, peat extraction, and urban and industrial development (wetlands are seriously affected by changes in land management and land use which lie inside as well as outside the planning process); and
- 72% of Local Authorities have no policy for the identification, assessment, preservation, or management of wetland archaeology.

It is therefore essential that effective mitigation strategies are developed and employed as soon as possible.

(www.english-heritage.org.uk)

The effective storage capacity of wetlands is strongly correlated to the maintained water level; the higher the water level, the less flood storage is available. In terms of flood control, this means that natural habitats are not all equally suited to use for (temporary) storage or as floodplain. The input of water of unsuitable quality could also mean a decline in the biodiversity of the natural habitat, and potentially a loss of the habitat type entirely. Clearly, this would conflict with elements of the Water Framework Directive and other legislation such as the Habitats Directive, and Wild Birds Directive.

Before using an existing natural habitat for storage, the objectives of the area in terms of species and habitat diversity, and the needs with respect to water quality and quantity (the frequency, timing and depth of flooding) that can be tolerated must be closely evaluated. It could be that in order to conserve the site, it is unsuitable for use in flood mitigation.

Conversely, highly productive habitat types (those suited to water high in nutrients) can be well suited for storage of floodwater or as floodplain. These types of habitats (such as reed-dominated wetlands), can be very valuable for birds, insects and other wildlife, and can also benefit water quality.

The restoration/creation of wetland habitats could fulfil a number of objectives including flood management and the enhancement of nature conservation. In general, when exploring the possibility of restoring wetlands for flood management, the needs (water quality and quantity, and general management) and expectations (goals in terms of species diversity, habitat type etc.) of the site should be considered.

The creation of water storage sites might require an adjustment or sacrifice of current land use practices, such as shifting from (intensive) arable agricultural use to extensive grazing or ceasing agricultural use completely in 'hot-spots'. Where an area is only expected to be affected by flooding on rare occasions and is still suited for commercial use, compensation for flooding might be sufficient. A number of examples are detailed below.

Project examples

Netherlands: Water Storage Needs Project (Habiforum, 2002)

In the Netherlands, an intensive, large-scale study of water storage needs and potential for combined use led to the identification of seven general designs for water storage. Each design describes a different type of storage and flood control, for example peak flooding, seasonal flooding, catastrophic flooding and potentially storage with slow-

release. The potential for combined use with cropping, grazing, recreation, biomass production, creation of (semi)natural habitat, and urbanisation has been evaluated (based on the flooding frequency, expected water quality and water level (fluctuation) of the storage design).

Wet Fens for the Future Initiative (Cambridgeshire County Council *et al*., 1996)

The Wet Fens for the Future Project (1999-2001) (part of the Wise Use of Floodplains Project detailed below) was funded by partners in government agencies in England, Local Authorities and voluntary organisations, and by the EU LIFE programme. The project covered the parts of west Norfolk, Cambridgeshire, Lincolnshire and Suffolk traditionally referred to as the Fens. Tools were developed to help identify and progress practical and sustainable options for managing river plains. For example, habitat restoration to conserve nationally scarce species and habitats, and provide washlands for flood defence and to attract tourists were central to the Wet Fens vision.

Wise Use of Floodplains (Anon, Undated; and Jenkins and Horrocks, 2002)

The Wise Use of Floodplains Project (1999-2002) demonstrated how floodplains could contribute to the sustainable management of water within river basins. The project was a pan-European partnership involving government organisations, research organisations and non-government organisations in six project areas throughout England, Scotland, Ireland and France. The project had a number of specific aims:

- To demonstrate methods to appraise the economic, environmental and social effects of flood and coastal plain wetland restoration and management options;
- To determine how European and national policies would need to change to facilitate the restoration of flood and coastal plain wetlands; and
- To facilitate the planning and implementation of floodplain restoration in other parts of Europe through the dissemination of guidelines and project results.

Key lessons demonstrated through the project include:

- Active public participation in decision-making produces successful outcomes; and
- Multi-use wetlands can be a viable, sustainable and desirable option.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X	X	X	X	X	X

Opportunities/barriers to change:

- Defining and meeting the needs of the existing nature conservation site in terms of water quality and quantity, and general management;
- Designing and implementing site-specific conservation management strategies for wetlands identified for protection;
- Identifying suitable sites and conditions for wetland restoration/creation;
- Promoting multi-functional use of wetlands;

- Developing conservation management strategies for wetland landscapes in partnership with other agencies (for example inclusion of cultural heritage and archaeological interests in conservation and wise use of wetlands); and
- Enhancing the protection of the cultural heritage of wetlands (including significant anthropogenic deposits, which cannot currently be scheduled as Ancient Monuments) through national and international legislation and conventions.

5.4.2 Burning

Fire has been used widely in Britain for heather management for over 200 years. Regular burning can maintain heather dominance and ensure the availability of young, nutritious shoots for grouse, sheep and other herbivores (English Nature, 2001). The importance of burning to the management of moorland vegetation is well documented and guidelines are available to landowners (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002). Most research has been carried out in connection with the management of heather-dominated communities at the drier end of the range, such as grouse moors or lowland heath. For most purposes (game management and nature conservation), it is preferable to burn small patches to maintain a diversity of age structure; for grouse moors, tall heather is required for shelter and over-wintering whilst short swards are required for feeding areas.

Severe fires can be extremely destructive of both vegetation and topsoils rich in organic matter. Changes to soil structure through repeated moor burning results in reduced infiltration, accelerated run-off and increased flood risk downstream. It is widely recognised that vegetation management in the headwaters will influence downstream flood peaks, although the magnitude of this effect is not well understood (Posford Haskoning and Royal Holloway Institute for Environmental Research, 2002).

Area(s) of relevance:

All conservation sites managed by burning (and farms and estates where burning is undertaken for the purposes of game management and/or nature conservation).

Opportunities/barriers to change:

- Adhering to good practice;
- Bracken composting (as a possible alternative to burning); and
- Habitat restoration.

5.5 Sustainable Land Management Strategies

In a catchment-based approach, the soil can be seen as the first line of defence (Environment Agency[a], Undated) (refer to Section 5.1). A range of field practices has been identified for having the potential to correct or prevent problems such as capping, compaction or puddling (National Soil Resources Institute, 2001; and Environment Agency[a], Undated). Next to measures such as converting agricultural land to natural habitat, which are likely to require compensation, sustainable land management strategies can be very effective in improving the soil structure and reducing flood risk (O'Connell *et al*., 2003). Some of these mitigation measures also apply to forestry and nature conservation practices.

By applying sustainable land management strategies as necessary, depending on the practicalities of the site, flood risk and extent can be minimised. Of the numerous strategies available, the following are deemed most relevant to a catchment-based approach to flood management:

- Integrated farm management;
- Improved livestock management;
- Improved soil management;
- Selection of appropriate pasture grasses;
- Maintenance of winter cover;
- Use of riparian strips; and
- Hedgerow management and planting.

Integrated farm management is a 'whole farm' approach that balances a variety of arable and livestock farming practices, and takes in to consideration both the economic aspect of farming and the needs of the environment. For example, this may include varying the layout of different crops relative to watercourses.

Improved livestock management involves moving livestock regularly, decreasing stocking densities and keeping livestock away from sensitive areas.

In general, improved soil management includes the following:

- Maintaining or increasing soil organic matter content;
- Improving infiltration and reducing capping by increasing surface roughness and depressional storage;
- Using cover crops and better rotations;
- Avoiding use of heavy machinery, especially on wet soil;
- Leaving trash residues on surface;
- Targeting treatment of tramline tracks;
- Improving void space in topsoil; and

- Securing beneficial land use change: increasing tree and woodland cover, organic farming, reversion of poorer quality arable land, construction of small or medium - scale ponds and winter-filled storage lagoons.

Further details are contained in Environment Agency[a] (Undated).

Sustainable land management strategies will be further promoted under the reform of the Common Agricultural Policy (refer to Section 6.7). However, there is a need to ensure awareness is raised with farmers and land managers, and that prescriptive measures are included in the definition of good agricultural and environmental condition.

Relevance to land uses

Upland				Lowland			
Arable	**Mixed**	**Pastoral**	**Forestry**	**Arable**	**Mixed**	**Pastoral**	**Forestry**
X	X	X	X	X	X	X	X

Opportunities/barriers to change:

- Increasing awareness;
- Adhering to best practice guidelines (such as the "Forest and Water Guidelines");
- Improved infiltration and soil storage capacity; and
- Linking financial payments to follow sustainable land management strategies more closely.

5.6 Case Studies for Evaluation at Catchment-Scale

As detailed in Section 5.1.1, the overall pattern of land use and scale of certain types of individual land uses are important considerations in attempting to reduce flood risk and extent. This section illustrates these aspects through a number of case studies.

5.6.1 Case study: Parrett Catchment (www.somerset.gov.uk; Land Use Consultants, 2001; Environment Agency and Lewin, Fryer and Partners, 2003; Environment Agency, 2002; and Thorne, 2003).

The Parrett Catchment Project demonstrates a catchment-based approach to flood management. Unfortunately, the work is currently at a strategic level and it is therefore not possible to fully evaluate its overall success. Nevertheless, the strategy used in the Parrett catchment is described below, to demonstrate how the objectives of a larger catchment can be developed into site-specific measures designed to address issues relevant at the local scale.

The Parrett catchment
The Parrett catchment is the largest river system in Somerset, covering approximately half the county and incorporating five major rivers: the Parrett, Isle, Yeo, Cary and Tone. Rising in parts of West Dorset and Exmoor, these rivers flow to the sea at Bridgwater. The floodplain that lies in-between forms a significant part of the Somerset Levels and Moors, which are of international importance for wildlife. Many areas of the catchment have been nationally and internationally designated as Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Ramsar wetlands of international conservation importance for overwintering wildfowl and aquatic ditch flora and fauna.

There are 47 SSSIs within the Parrett catchment with a total area of approximately 9,377ha. Of these, 41 are biological SSSIs and 6 are geological SSSIs. Key sites include West Sedgemoor SSSI/SPA, Southlake SSSI/SPA and Curry Moor SSSI/SPA.

The Parrett catchment includes part of the Blackdown Hills and Quantock Hills Areas of Outstanding Natural Beauty, as well as a small part of Exmoor National Park. In addition, a large proportion of the catchment has been designated as a Special Landscape Area by Somerset County Council (Environment Agency and Lewin, Fryer and Partners, 2003).

Somerset has a rich cultural history with 11,000 known archaeological sites, monuments and finds. Approximately one-third of the county's 184 Conservation Areas are situated within Outstanding Heritage Settlements, many of which lie within the Parrett catchment. There are also a number of important historic landscapes within the area including the Battlefield of Sedgemoor (1685).

The main land use is agriculture including dairy, beef and sheep farming. In the upper catchment (outside the Levels and Moors), the primary land use comprises dairy, sheep and beef production, although in recent years arable crops (such as cereals, potatoes, flax and maize) have become more prominent. The catchment also has dispersed urban development, with the three major centres of Yeovil, Taunton and Bridgwater (Environment Agency and Lewin, Fryer and Partners, 2003).

Much of the catchment receives higher than average rainfall and the capacity of the river channels in the lower reaches is often exceeded. There is currently little (man-made) water storage in the upper catchments.

Tourism generates £85.6 million in the county per annum (by day visits), with the total spent by staying visitors being almost £300 million (Environment Agency and Lewin, Fryer and Partners, 2003). Visitors are generally concentrated in West Somerset, Sedgemoor and the coast.

The Parrett catchment project
In response to concern over the negative effects of flooding (including the increased frequency and duration of flooding), the Somerset County Council, Levels and Moors Partnership, the Environment Agency, English Nature and RSPB in co-operation with others set up the Parrett Catchment Project (2000) (Land Use Consultants, 2001).

The essential aim of the programme is *"to develop a long term Action Strategy for land and water management and identify a new package of largely rural, agricultural and other land-based activities for the southern part of Somerset"* (Land Use Consultants, 2001).

The objectives of the project include:

- Developing an integrated catchment management plan;
- Developing a sustainable approach to integrated flood management across the whole catchment;
- Providing a range of measures for modifying land use across the catchment; and
- Developing an integrated approach to rural development.

The groundwork for the establishment of the Action Strategy, set against a 50-year time-scale, and developed to guide integrated decision-making with respect to land use and water management in the catchment, consisted of the following stages:

- Identifying key issues for the catchment; and
- Reaching a consensus about what matters and how the future should be planned.

The themes investigated for opportunities to bring about beneficial changes in land use and water management practices in the catchment were:

- Climate change;
- Rural land use (farming, the environment, landscape, profitability, land management practices and incentive schemes for environmental benefit);
- Economic performance;
- Social and community welfare;
- Environmental issues (nature conservation, landscape and cultural heritage); and
- Water management (confidence and communication).

Two key points identified with respect to land use and flood management were:

- The temporary storage of floodwater on the Levels and Moors (when it cannot be evacuated to sea) during a flood event provides a public service to the residents and businesses in the lower catchment urban areas. However, the disbenefits to storing this water, such as damage to willow withy production, should also be recognised; and
- The national and international importance of the wet grasslands of the Levels and Moors for wetland wildlife and archaeological conservation needs to be safeguarded.

Based on the opportunities identified in existing land use and water management practices and the participatory consensus, a vision of the Parrett catchment was devised. The vision addresses issues such as integrated management, rural land use, nature conservation landscape and archaeology.

A range of measures for improving water management in the catchment were considered including improved agricultural land management, creation of on-farm storage, maintenance of existing habitats, and creation of new ponds and wetlands as water retention nature reserves. In total, 11 potential measures were identified. Further details are contained in Land Use Consultants (2001).

The environmental, social and economic implications of the suggested measures were further evaluated at a broad brush level as part of the Parrett Catchment Flood Management Plan (2003).

Finally, the catchment was divided into seven Flood Management Units (FMUs), where the flood risk and mechanisms are similar. Based on the flood management problems within each FMU, a set of measures was drawn up. A complete overview is detailed in Environment Agency and Lewin, Fryer and Partners (2003).

5.6.2 Case study: The Yorkshire Ouse (www.euroharp.org/map/img/eng.htm; and www.ecars.com.au/2000/001104-Yorks.html).

The Yorkshire Ouse is one of the principal river basins in the north east of England; being formed by the confluence of the Rivers Swale, Ure and Nidd. The Ouse flows in a south easterly direction through the Vale of York. The Rivers Swale, Ure and Nidd rise on the Pennines and North Yorkshire Moors to the north and west; draining predominantly agricultural land and moorland. York is the largest urban centre on the River Ouse.

The Ouse catchment area is approximately 3,315km^2 with a rainfall range of 600-2,000 mm per annum. The dominant land use is arable and mixed farming with interspersed cattle and sheep grazing. The Vale of York is used for intensive arable production including wheat and sugar beet.

In 2000, torrential rains brought widespread flooding in York with 3,000 homes evacuated and 1,000 underwater. The peak of the flooding was the highest level recorded since records began in 1625. Studies undertaken by the Soil Survey and Land Research Centre suggested that land management had affected in-field run-off (Royal Society for the Protection of Birds, 2001).

In the Forestry Foundation Strategy for Yorkshire and the Humber (Firn Crichton Roberts Ltd and John Clegg Consulting Ltd, 2002), the Forestry Commission, Yorkshire Forward and their strategy partners accepted a strategic recommendation to address the growing River Ouse flood problem through increased planting of appropriate forests and woodlands throughout the river's catchment area.

5.6.3 Case study: Pontbren, Wales (Bird *et al*., 2003).

Following the heavy flooding during 2000/2001 in England and Wales, the Countryside Council for Wales (CCW) (in conjunction with the Welsh Assembly Government, Forestry Commission Wales and Natural Environment Research Council) commissioned a study to investigate the impacts of tree plantations on soil function at the Pontbren group of farms in mid Wales.

Seven study sites were selected that represented a range of plantation ages (2 to 7 years old), landscape positions, locations and tree compositions. Two baseline sites, where large plantations are planned, were selected, and an established woodland site was chosen in order to provide comparative data.

Key findings included:

- Mean infiltration rates were higher in the tree plantations compared to the open grazed pastures. Continuous, steady infiltration has a mean of approximately 1m/h 5m into the tree plantations, although was negligible 5m into the grazed areas.

- The infiltration data suggest that the impact of the trees extends beyond the plantation boundaries into the grazed areas.

- Soil surface compaction followed a similar trend to water infiltration with lower values in tree plantations compared to open grazed pastures.

However, it was concluded that this study provides only preliminary findings and further research is required to investigate the issues fully. One challenge is to 'scale up' the observations at Pontbren to the catchment-scale. Howard Wheater at Imperial College, London, is currently leading a programme of wider research (refer to Section 3.3).

5.6.4 Case study: Severn Vyrnwy (Defra *et al*., 2003; and Dr A Cott, Project Manager, Severn Vyrnwy LMI, pers. comm., February 2003).

The Countryside Agency's programme of nine Land Management Initiatives (LMIs) includes the Severn Vyrnwy Floodplain LMI in the Shropshire Marches. The LMIs are demonstrating in a practical way how England's rural land management and farming systems can respond to changing demands whilst maintaining a healthy, attractive environment and thriving rural economies.

The confluence of the River Severn and River Vyrnwy is situated 10 miles west of Shrewsbury. The area has been improved for agriculture with the historic loss of wetlands. Currently, there is extensive winter flooding.

The focus of the Severn Vyrnwy Project, covering 150km^2 and involving 300 farms (predominantly dairy/mixed farms, with an average size of 50ha), is:

- Facilitating change in attitudes and farm practices;
- Influencing policy development;
- Integrating public and private thinking and funds; and
- Delivering benefits for all in the countryside.

The wider Severn Vyrnwy Washlands are situated at the confluence of the Rivers Severn and Vyrnwy. The area comprises 6,800ha of low-grade agricultural land, providing large volumes of temporary flood storage. Embankments exclude floodwater up to approximately the 1 in 5 annual probability. The Washlands provide flood protection to riverside properties in Shrewsbury; increasing the threshold of flooding to 1 in 15.

A multi-functional wet washland pilot scheme has been proposed for the upper reaches of the Severn at the Severn Vyrnwy confluence. In summary, this will provide the following benefits:

- New off-line storage of approximately 13.5 million m^3 of floodwater at peak flow;
- Create over 300ha of wet grassland, a UK Biodiversity Action Plan priority habitat;
- Flood defence and habitat benefits gained through a system of fluvial exchange; and
- Potential economic benefits derived from eco-tourism and other related activities.

The project involves a range of organisations including the Environment Agency, English Nature, Shropshire Wildlife Trust, CCW and Severn Trent Water Ltd.

The partnership vision is *"To achieve the recovery and improvement of riverside landscapes along the River Severn Corridor by the planned expansion and enhancement of wetland habitats and the development of sustainable flood alleviation and land use systems which contribute to local communities"*.

The project promotes the integrated management of wetlands to provide flood alleviation benefit by identifying the requirements and interests of landowners and developers, and planning sustainable development. In this way, it complements the Environment Agency's strategies for the River Severn including the Severn Catchment Flood Management Plan and the Fluvial Severn (Flood Management) Strategy.

While it is recognised that the washland will provide a significant benefit in reducing flood levels in the Upper Severn and Shrewsbury, this is only part of a package of measures required to tackle flooding.

5.7 Significant Findings

As detailed previously, different land management practices can significantly affect in-field surface run-off, and can influence the timing and magnitude of land drain response. This section summarises which land use practices increase flood risk and extent most significantly for each policy area.

5.7.1 Agriculture

- The pattern and scale of single land use operations;
- Land drainage, depending on the soil type and wetness regime (quantifiable evidence available);
- The move away from mixed agriculture to more specialised systems, and the consequent decline in on-farm organic matter for soil nourishment;
- Arable land management (such as untimely operations on susceptible soils), leading to soil compaction, puddling, capping and plough pans (quantifiable evidence available);
- Cultivating 'risky' crops such as maize (quantifiable evidence available);
- Grazing in certain geographical locations and under specific management regimes, leading to soil compaction (quantifiable evidence available); and
- The loss of on-farm water storage systems and features including ponds.

To a lesser extent:

- Water abstraction where there are large-scale commercial users of water.

5.7.2 Forestry

As woodland management activities now have to meet the UK Forestry Standard for delivering sustainable forest management and any afforestation, deforestation, road building and forest quarries are subject to an EIA, the impact of woodland practices on flood risk and extent is now relatively small. Those practices that have minor effects are:

- Tree removal (quantifiable evidence available);
- Harvesting operations (localised impacts); and
- Drainage (localised impacts, declining with time).

5.7.3 Nature Conservation

- The requirements for high water tables in specific sites (may conflict with flood management as soil storage is reduced).

The land use practices, which offer the most potential for integrated flood management at the catchment-scale, are summarised in Table 5.1.

6 ORGANISATIONS AND CONTROL MECHANISMS

6.1 Introduction

This section presents an overview of the organisations responsible for agriculture, forestry and nature conservation together with the control mechanisms (including policy, regulatory and budgetary instruments) which affect these areas. In particular, the organisations, roles and responsibilities of the main policy organisations are reviewed; the principal policy delivery mechanisms explained; and the key future influences on policy, strategy and activities explored.

The inter-related policy frameworks for agriculture, forestry and nature conservation in England and Wales are relevant to the present and future relationships between each policy area and flood management. It is therefore important to briefly describe the present and prospective frameworks before reviewing the mechanisms and organisations that operate within them.

6.2 The Agricultural Framework

6.2.1 Mechanisms Controlling the Agricultural Framework

The EU Common Agricultural Policy (CAP), which was introduced in 1962, is currently the most important mechanism controlling the agricultural framework within the UK. The original concept of the CAP was driven by the strategic need for food security in post-war Europe. The main regulatory instruments adopted were market support (for example subsidies) and protection of the domestic market (for example import tariffs). However, the intensification of production led to environmental damage, as well as a large economic burden (www.defra.gov.uk/farm/capreform/). Over time, a number of reform measures were adopted such as constraining production (via compulsory set-aside for arable crops), decreasing the production price, introducing payments for environmentally beneficial forms of farming, and placing a greater emphasis on rural development.

The Agenda 2000 agreement, agreed in March 1999, cut prices for cereals, milk and beef, and agreed the Rural Development Regulation (RDR), which underpins what is referred to as the Second Pillar of CAP. In summary, Member States formulated seven year (2000-2006) Rural Development Programmes (RDPs), which utilise measures in the RDR to provide agri-environment and rural development support. The RDPs for England, Wales and Scotland are outlined below. In addition, Agenda 2000 agreed horizontal provisions which enable Member States to ‘divert’ up to 20% of compensatory direct payments to fund various aspects (including agri-environment schemes, Less Favoured Area (LFA) support, afforestation of agricultural land and early retirement schemes) under the RDR. This process is termed modulation.

Rural Development Programme for England
The England RDP (ERDP) is aimed at diversifying and increasing the competitiveness of farming and forestry businesses, developing new food and non-food products, ensuring the sustainable management of LFAs, and significantly increasing the areas covered by environmental schemes. The priorities for action are:

- Priority A: Creating a productive and sustainable rural economy.

This category includes the Energy Crops Scheme and the Rural Enterprise Scheme (RES). The RES embraces a wide range of activities to support rural communities and help farmers adjust to the declining role of agriculture.

- Priority B: Conserving and enhancing the rural environment.

This priority includes three agri-environment schemes:

- The Organic Farming Scheme;
- The Countryside Stewardship Scheme (CSS); and
- Environmentally Sensitive Areas Scheme (ESAS).

The Organic Farming Scheme encourages farmers to convert to organic production methods as a means of improving the environment, and responding to the growing demand for organic produce.

The CSS makes payments to landholders and land managers to improve the natural beauty and diversity of the countryside.

The ESAS covers 22 specific areas of national environmental significance and offers different payment levels to farmers, depending on the nature of their agricultural management agreement.

Rural Development Programme for Wales
The RDP for Wales aims to strengthen farm businesses through increased productivity and diversification, support rural communities by increasing employment opportunities, and extend initiatives to protect the environment and rural heritage. The priorities for action are:

- Priority 1: To create stronger agriculture and forestry sectors.

Grants are available for investments to improve farm practices beyond minimum standards and diversify farming activities (such as stock and crop management).

- Priority 2: To improve the economic competitiveness of rural communities and areas.

The four key sectors involved are lamb, beef, dairy and organic produce. Training helps farmers adapt their businesses to changing market conditions. In addition, Processing and Marketing Grants finance investments in buildings and equipment.

- Priority 3: To maintain and protect the environment and rural heritage.

An integrated whole farm agri-environment scheme, Tir Gofal, operates throughout Wales. Tir Gofal aims to encourage agricultural practices, which will protect and enhance the landscapes of Wales, their cultural features and associated wildlife. It is also intended to improve public access to the working countryside, and provide new opportunities for on-farm environmental training and education.

The Organic Farming Scheme provides payments in the first five years of conversion to organic status. The payments also take into account the protection of the environment provided by the prescriptions of the scheme.

Rural Development Programme for Scotland
The RDP for Scotland aims to promote the sustainable economic, environmental and social development of rural areas through extensive land management and enhancing biodiversity, encouraging diversification into forestry, and supporting farm incomes in LFAs (Scottish Executive Environment and Rural Affairs Department, 2002). The priorities for action are:

- Priority 1: To assist the viability and sustainability of Scottish farming.

The measures under this priority cover forestry and the LFAs. The LFA payment is designed to support agriculture in its traditional areas, and to ensure sustainable farming practices are undertaken.

- Priority 2: To encourage farming practices, which contribute to the economic, social and environmental sustainability of rural areas.

This priority comprises the following agri-environment schemes:

- The Rural Stewardship Scheme (RSS);
- The Organic Aid Scheme (OAS); and
- The Environmentally Sensitive Areas Scheme (ESAS).

The RSS offers a comprehensive range of environmental prescriptions (for example wetland features, woodland and scrub, historic and archaeological sites), outlining the management requirements for each priority.

The OAS encourages farmers to convert to organic production by offering compensation for income losses during the conversion period.

The ESAS will be extended to allow for collaborative applications from groups of farmers and crofters (British Wildlife, October 2003).

Hill Farm Allowance (England, Wales and Scotland)
The Hill Farm Allowance (HFA) is one of the schemes comprising the country RDPs. This replaced the Hill and Livestock Compensatory Allowance as support for farmers in LFAs within England, Wales and Scotland. Sheep and/or suckler cow producers with at least 10ha of eligible forage area may claim HFA payments. For 2004, there are two payment elements available:

- A basic area payment (based on land classification and size of holding); and
- Additional payments for meeting certain environmental criteria.

Sheep Annual Premium Scheme (England, Wales and Scotland)
The Sheep Annual Premium Scheme (SAPS) offers fixed rate premiums in England, Wales and Scotland. In summary, the premium is paid on a headage basis for female sheep, which have given birth or are at least one year old at the end of the retention period (100 days following the end of the application period). A lower rate of premium is paid for sheep kept for milking, with supplements paid for those keeping sheep in LFAs. Under the EU Sheepmeat CAP regime, additional funding is currently available to Member States to provide more flexibility in the ways that the sheep sector is supported. The total amount available in the UK is 20.16 million Euros (approximately £13 million at the present exchange rate), and this may be allocated to separate national envelopes (refer to *Single Farm Payment implementation in England, Wales and Scotland* below for further details). National envelopes therefore provide the opportunity to encourage more environmentally friendly farming practices. For example, in England, the national envelope for 2003/2004 comprised:

- The Sheep and Wildlife Enhancement Scheme (detailed below); and
- The Better Returns Programme, which gave practical advice to farmers on how to secure better market returns.

The Sheep and Wildlife Enhancement Scheme
The Sheep and Wildlife Enhancement Scheme (SWES), funded by Defra and delivered by English Nature in 2003, was based on the principle that many important and extensive wildlife habitats require sustainable grazing in order to maintain their conservation interest. The SWES will operate in 2004 with the intention to primarily focus on the lowlands.

Arable Area Payment Scheme (England, Wales and Scotland)
Under the existing CAP arrangements, the Arable Area Payment Scheme (AAPS) for England, Wales and Scotland is ongoing (with some minor changes for 2004), although it is due to be replaced by a new scheme in 2005. The AAPS offers area payments on eligible land to growers of cereals, linseed, oilseeds, protein crops, and flax and hemp for fibre. An exception the EU has allowed since AAPS began is land that was under certain multi annual crops on 31 December 1991 is now regarded as eligible. In some circumstances, Member States can also authorise the transfer of eligibility from land which meets the normal requirements to land which does not. In addition, aid may be paid for fibre flax and hemp, though not other crops, when they are grown on land which is not eligible for AAPS but on which fibre flax or hemp was grown and received payment under the fibre flax and hemp subsidy schemes in 1998, 1999 or 2000. This eligibility cannot be transferred to other land (www.defra.gov.uk/farm/schemes/aap_sa.htm).

The conditions for claiming payments are that large farmers must set aside a certain percentage of their land, and must comply with the rules for managing set-aside. Small farmers are not required to have set-aside, although they are permitted to have it if they wish.

6.2.2 Ongoing CAP Reform

The Agenda 2000 agreement anticipated the need for a review of some CAP sectors in 2002-2003, which was undertaken as the Mid Term Review. Draft legislation detailing the proposed reforms was published in January 2003. The broad proposals are:

- To replace the current direct support payments (Pillar I) to farmers with a Single Farm Payment not linked to production (termed decoupling);
- To increase funding for the RDR (Pillar II) including agri-environment schemes and the RES; and
- To modulate payments (i.e. re-directing direct payments to farmers to help fund the RDPs).

Single Farm Payment

A new Single Farm Payment will be implemented from 1 January 2005 on a country-by-country basis, although Member States may opt for a later starting date up to January 2007 (European Commission, 2003). At present, it is envisaged that the Single Farm Payment will be payable on land in agricultural production only. England, Wales and Scotland will decide on its specific implementation according to local priorities (refer to *Single Farm Payment implementation in England, Wales and Scotland* below for further details). The payments will be conditional on land managers meeting statutory management requirements as laid down in the Directives on Nitrates, Groundwater, Sewage Sludge, Pesticide Authorisation, Wild Bird, and Habitats and Species, as well as minimum standards of good agricultural and environmental condition. Refer to *Cross-compliance conditions* below for further details.

Cross-compliance conditions

The 2003 CAP reform introduced compulsory cross-compliance across the EU. This involves respect of both environmental standards and minimum requirements for good agricultural and environmental condition. Compliance with good agricultural and environmental condition would ensure that the necessary requirements for receipt of the Single Farm Payment are met. The draft Horizontal Regulation states that the minimum requirements for good agricultural and environmental condition will be defined by Member States at the national or regional level, taking into account the specific characteristics of the area concerned including soil and climatic condition, existing farming systems, land use, crop rotation, farming practices and farm structures. A broad framework is therefore established, however it is clear that good agricultural and environmental condition will need to be geographically fine-tuned. For example, draft proposals for a Welsh code of good agricultural and environmental condition include minimum soil cover, standards for crop rotations, arable stubble management and protection of permanent pasture.

Single Farm Payment implementation in England

It is currently envisaged that the Single Farm Payment will be based on a flat rate payment system, with ‘entitlements’ allocated to farmers on the basis of the number of eligible hectares. This flat rate will be phased in over a transition period, finishing during 2012 in order to avoid a rapid redistribution of income. To calculate the payments England will be divided into two regions, with different flat rates applying. All the land in LFAs will comprise one region, and the remainder of England another. The option of a national envelope has been discarded.

During the transition, the value of individual 'entitlements' will initially be based to a large extent on individual historic receipts from existing schemes. This element will reduce as the flat rate element increases. The proportion of funds allocated to the flat rate element will be 10% in 2005 and 15% in 2006, increasing in intervals of 15% until 2012, at which point, all payments will be given on this basis (www.defra.gov.uk/farm/capreform/spayeng01.htm).

Piloting an Entry Level Scheme in England
The government in England is currently piloting a 'broad and shallow' agri-environment scheme. The Entry Level Scheme (ELS) is being tested in four areas of the country under different land use regimes (grassland in Devon, arable production in Lincolnshire, upland farming in County Durham and mixed farming in Berkshire). The ELS aims to encourage a large number of farmers across a wide area to deliver simple yet effective environmental management. It is envisaged that this will help to address particular countrywide environmental problems that cannot be completely resolved by focusing on relatively small and isolated areas. The available options include reducing soil erosion, and encouraging diversity of crop type. Entry is linked to a whole farm audit (i.e. record of environmental features and areas) and plan. A Higher Level Scheme will implement more detailed agri-environment measures, potentially replacing the existing CSS and ESAS. If the ELS Pilot is successful it will be rolled out across England in 2005.

Single Farm Payment implementation in Wales
In Wales, the implementation of the Single Farm Payment will be based on a historical model. One reason for this is to avoid disadvantaging the smaller Welsh traditional family farm. However, this option may conflict with the decision made by England, particularly in relation to those farmers whose land is close to the border. Further consultation will be held on cross-compliance regimes, the use of national envelopes and the operation of a national reserve.

Proposed extension of Tir Gofal in Wales
It is recognised that the scope of Tir Gofal could be enlarged by adopting a comprehensive tiered structure (broad and shallow at the base, targeted and landscape-scale at the top) (Welsh, 2002). The proposed structure would be:

- Level 1 - Base tier: Entry Level (equivalent to the existing Tir Gofal whole farm plan);
- Level 2 - Middle tier: Habitat restoration and creation prescriptions, and new access opportunities (equivalent to the existing Tir Gofal targeted improvements for biodiversity or access); and
- Level 3 - Top tier: Landscape-scale environment, biodiversity and access benefits.

Level 1 would be a simple, easy to administer, 'broad and shallow' scheme, with a whole farm plan being produced by those applying for payment (such as a soil management plan). The current Tir Gofal scheme would be retained as Level 2, and involve the delivery of more demanding habitat and access management requirements. In the new top tier, the focus would be on group applications and delivering environmental, biodiversity and access benefits at the landscape-scale. Functional and/or socio-economic units may include farms comprising discrete hydrological units or catchments, and commons management associations (Welsh Assembly Government, 2003).

Single Farm Payment implementation in Scotland
In Scotland, full de-coupled payments will be based on historic receipts from 2000 to 2002. It is envisaged that this approach will provide stability for farmers to adapt to change. Scotland will also use national envelopes for the beef sector. Modulation will be moved to a combined rate (EU and national) up to at least 10% by the end of 2007. This decision could double the modulation funds currently available for investment in environmental and sustainable development schemes.

Ongoing reform of the CAP is putting in place further changes to the way the agricultural sector receives subsidies; with resources progressively transferring to Pillar II of the CAP to pay for rural development and environmental protection schemes. While existing agri-environment programmes will require support, as agreements are ongoing, the way in which reform will be translated into specific actions is not fully known at present. In the interim period, national envelopes can be used to support farming systems or marketing initiatives that deliver environmental benefits. The next rural development planning period (2007 - 2013) will be critical, eventually linking to a further review of the CAP.

6.2.3 Key Organisations and Actors that Impact on Mechanisms

The main organisations within the agricultural framework comprise the country government departments: The Department of the Environment, Food and Rural Affairs (Defra) in England, the Department for Environment, Planning and Countryside of the Welsh Assembly Government, and the Scottish Executive Environment and Rural Affairs Department (SEERAD). These organisations lead on policy and allocate national (state-aided) and EU funding.

Rural Payments Agency (England)
The Rural Payments Agency (RPA), an Executive Agency of Defra, is the single paying agency responsible for CAP schemes in England and certain schemes throughout the UK. It also currently conducts inspections relating to auditing of payments under the CAP. The full development of the RPA will take until 2005 and involves a major change programme.

Rural Development Service (England)
The Rural Development Service (RDS) administers existing agri-environment schemes under the England RDP and other non-ERDP schemes (such as the Farm Waste Grant available to farmers in Nitrate Vulnerable Zones). It also delivers a range of statutory services, for example policy advice on land and wildlife management. Other rural services provided include the delivery of sustainable development objectives and statutory functions through the National Land Management Team.

Farm advisory services (England)
Farm advisory services are fragmented in England, with a number of organisations fulfilling this role including the RDS, the National Farmers Union, the Farming and Wildlife Advisory Group, the Agricultural Development and Advisory Service, and the Environment Agency. Selected details are provided below.

The National Farmers Union (NFU) represents farmers and growers in England and Wales. *"Its central objective is to promote successful and socially responsible agriculture and horticulture, while ensuring the long-term viability of rural communities"*

(www.nfu.org.uk/intradoc…). The NFU offers a range of advice including "Computer Solutions" (in collaboration with Farmers Weekly), to source the ideal solutions for farm businesses.

The Farming and Wildlife Advisory Group (FWAG) receives funding through membership subscriptions. It is also sponsored by various organisations such as Defra, the Environment Agency and the Royal Society for the Protection of Birds. FWAG's whole farm conservation advice includes "Farm BAP", "Nutrient Budget", "Farm Technology Review" and "Water Management Guide".

The report of the Policy Commission on the Future of Farming and Food (2002) proposed the development of a centralised Farming Advice Line to signpost farmers to the best advice currently available. It was envisaged that this would act as a front-end to existing government-sponsored services and a gateway to the advisory functions of other bodies.

The Department for Environment, Planning and Countryside (Wales)
The Department for Environment, Planning and Countryside currently comprises five Divisions, the largest being the CAP Management (CAPM) Division. CAPM's responsibilities include making CAP payments to farmers, applying scheme rules and administering control schemes. Responsibility for dealing with agri-environment and agricultural schemes lies with the Food and Farming Development Division (FFDD). FFDD undertakes a wide range of activities including:

- Training and advisory services to help farmers adapt and modernise;
- The Organic Farming Scheme;
- Grants to improve marketing and commercial expertise within the food and farming sector; and
- Taking forward the proposals for Farming Connect (see below).

In addition, The Agriculture and Fisheries Policy Division is responsible for formulating general policy for agriculture.

Farm advisory services (Wales)
Farming Connect is a one-stop shop, offering services to the farming community. It is mainly funded through EU Objective 1 money, and aims to provide farming businesses with the information and expertise to help them make informed decisions. The services include:

- Facilitators;
- Farm Business Development Plans (including farm business health check and action plan);
- Environmental/pollution control and advice;
- Machinery rings;
- Literature; and
- Technical advice.

The services can be accessed by contacting the Welsh Development Agency staff at the Farming Connect Service Centre, or by contacting a local Farming Connect facilitator.

SEERAD (Scotland)
SEERAD is responsible for implementing the strategy adopted by the Scottish Executive to promote the sustainability and profitability of farming. This embraces CAP reform, the encouragement of the organic sector, and a commitment to the responsible stewardship of the land.

Farm advisory services (Scotland)
Farm advisory services are delivered by the Advisory Division of the Scottish Agricultural College through its nationwide office network. Other relevant organisations include the Scottish Environment Protection Agency, FWAG and the other six Scottish Agricultural and Biological Research Institutes (SABRI) such as the Macaulay Institute in Aberdeen, which is the prime land use research and advisory institute in Scotland.

6.2.4 Summary of Future Trends and Drivers in the Agricultural Framework

The future trends and drivers are likely to be:

- Ongoing CAP reform;
- EU environmental legislation in relation to biodiversity, sustainability, water and soil (such as the Water Framework Directive, Environmental Liability Directive and Soils Directive);
- Country-based environmental and social legislation;
- Continuation of the current trend towards regional and local delivery of government policy;
- Enlargement of the EU (i.e. budgetary pressures);
- Ongoing negotiations with respect to the World Trade Organisation agreement on agriculture (i.e. trade liberalisation, cutting subsidies on EU production and export subsidies, and allowing easier access for imports);
- Need to deliver better value for money to taxpayers and consumers;
- Greater reflection of animal welfare concerns;
- Need to improve environmental stewardship;
- Need to increase the profitability of farming;
- Climate change;
- Ongoing trend towards locally produced and marketed food (for example Somerset Pride, a non-profit making co-operative of small livestock farmers); and
- Ongoing trend towards organic food.

6.3 The Forestry Framework

The forestry sector throughout Great Britain has been subject to an increasingly wide range of national and international policies and priorities throughout the period since the establishment of the Forestry Commission in 1919. The initial policy focus was on re-establishing a strategic reserve of home-grown timber to replace the forests and woods felled to meet the needs of the First World War. Over the past thirty years, forestry policy has both evolved and changed its policy objectives towards encouraging investment in establishing and managing forests and woodlands to meet a portfolio of economic, environmental and social objectives. The policy framework for forestry and woodlands in England and Wales is now perhaps one of the most sophisticated in the rural sector; where investment and activity is shaped through a complex mix of policy, strategy, regulation, budgetary support and exhortation; and which is promoted in international, EU, UK and national contexts. The policy framework within which the

sector operates is summarised in Appendix B, and the main organisations that influence forest policy and its delivery are described in Appendix C.

6.4 Mechanisms Controlling the Forestry Framework

Forest policy in England and Wales is directly or indirectly delivered by a number of government departments and agencies detailed in Table 6.1 below.

Table 6.1 - Forestry Organisation in England and Wales

Activities	England	Wales
Forestry	Forestry Commission National Office for England	Forestry Commission National Office for Wales
Agriculture	Defra	The Department for Environment, Planning and Countryside
Environment	English Nature, Defra	Countryside Council for Wales Welsh Assembly Government

The delivery mechanisms of these organisations are described in the following sections.

6.4.1 Forestry Commission

The Forestry Commission is the government department with overall responsibility for forestry in Great Britain, although policy and operational activities have now been devolved (refer to Table 6.1). There are two main mechanisms for the delivery of forestry policies in England and Wales: one is directly through the English Parliament's and the Welsh Assembly's woods; and the other is indirectly through influencing the activities of other woodland owners. In this section, these two sets of activities are described. In the following section, the mechanisms for co-ordinating the delivery of forest policy with those of other government policies are discussed.

Direct policy delivery in the English parliament's and the Welsh Assembly's woods
The English Parliament owns some 257,000ha of land in England, of which 206,000ha are woodland; the Welsh Assembly owns approximately 129,000ha of land in Wales, of which approximately 113,000ha are woodland. The English Parliament and the Welsh Assembly, through the Forestry Commission England and the Forestry Commission Wales respectively, therefore have major roles in the direct delivery of their forest policies. Management decisions with respect to individual woods are the responsibility of District Managers within Forest Enterprise (the estate management arm of the Forestry Commission), who are ultimately responsible to their Forestry Commission Operational Directors for England and Wales.

The woodlands are all managed according to the UK Forestry Standard (UKFS), which was drawn up following wide consultation. They are also all independently certified as being managed on a sustainable basis through the UK Woodland Assurance Scheme (UKWAS).

Indirect influence through Forestry Commission England and Forestry Commission Wales activities
The Forestry Commission England and the Forestry Commission Wales are responsible for setting standards in both public and privately -owned woods; providing financial incentives to encourage private woodland owners, Non-Government Organisations and Local Authorities to deliver each country's forest policy; ensuring that regulations for plant health and tree felling are complied with, and administering the Environmental Impact Assessment Regulations as they relate to forestry.

Financial incentives are a very important mechanism for the delivery of forestry policy in each country. Both England and Wales have Woodland Grant Schemes (WGS), although they are entirely separate in the way they operate since the two countries have

separate forest policies that they are designed to help in delivering. The main components of the two schemes currently are:

- Grants for new planting;
- Grants for re-stocking woodlands;
- Woodland management grants; and
- Woodland improvement grants.

Woodland Improvement Grants cover developing recreational facilities; bringing under-managed woods or woods of little commercial value into management; and encouraging and supporting biodiversity.

These are part-funded by the EU and are delivered as components of the England and Wales Rural Development Programmes (RDPs), although these are presently under review as part of an evaluation of the RDPs. In England, WGS applications are evaluated according to a publicised point-scoring system, which provides a weighting according to the scale of the delivery of public benefits. The main elements that are scored in England are:

- Rural development;
- Economic regeneration;
- Recreation, access and tourism;
- Environment and conservation;
- Size;
- Landscape enhancement; and
- Other additional factors, such as community involvement.

The grants in England are likely to change in 2005, although the priorities indicated via this scoring may not change significantly. No such scoring system is used in Wales. However, there are an increasing number of woodland owners who are managing their woodlands under UKWAS and therefore, take into account all the wider environmental and social impacts of their woodland management activities.

Fiscal incentives (tax) remain the responsibility of the UK Treasury and at present, no specific fiscal incentives exist for the implementation of forest policy. The only fiscal incentives, which apply equally to agricultural businesses, are the availability of Business Assets Relief for established commercial woodlands, and roll-over relief on the purchase of land in certain circumstances.

Unless tree felling is in accordance with an approved plan of operations under one of the Forestry Commission's grant schemes, a tree felling licence is almost always required if more than three cubic metres of timber are to be felled in any one quarter. Failure to obtain a felling licence will lead to penalties that are set out in the Forestry Act 1967 as amended. This legislation provides a powerful mechanism for the control of tree felling in England and Wales. The Forestry Commission will not normally grant a felling licence unless the proposals are in accordance with an agreed landscape plan, and the area is to be re-planted with respect to the agreed plan. Consultation on these plans will have taken place in line with the agreed national procedures (see below). Details of all felling licence applications are available in the local Forestry Commission office, on the Forestry Commission's web site, and are sent to all the relevant statutory consultees.

Trees and woodlands, particularly in urban and peri-urban areas, may be subject to Tree Preservation Orders (TPOs), which can be applied by Local Authorities. Any felling of trees subject to a TPO has to be approved by the Local Authority.

As detailed in Section 4.3.7, the Forestry Commission is required to ensure compliance with EU legislation. As a result, the Forestry Commission will call for an EIA for all afforestation, deforestation, road building and forest quarry developments if the scale of the operations exceed certain threshold values.

The Forestry Commission also provides a considerable amount of information to woodland owners through the provision of leaflets and reports; their web site; and through seminars. This is seen as an important mechanism for the delivery of forest policy through the opportunity it provides for informing and influencing the activities of woodland owners.

6.4.2 DEFRA and Department for Environment, Planning and Countryside

One of the EU measures which is delivered through the England and Wales RDPs is the Farm Woodland Premium Scheme (FWPS). One of the objectives of the RDPs is to encourage farmers to diversify their farming activities through planting trees. Defra in England and the Department for Environment, Planning and Countryside in Wales pay compensation through the FWPS to owners of land for their loss of income as a consequence of converting agricultural land to woodland.

The agreed arrangements between the Forestry Commission's national offices and Defra and the Department for Environment, Planning and Countryside are that landowners wishing to enter FWPS must first enter the WGS. Once the Forestry Commission has approved the scheme, Defra and the Department for Environment, Planning and Countryside will accept the application into the FWPS provided it meets all the necessary criteria for their scheme. As a result, this arrangement ensures that all the consultation arrangements described below are complied with.

6.4.3 English Nature, Countryside Agency and Countryside Council for Wales

In England and Wales, forestry policies are increasingly aligned to conservation and recreation policies delivered through English Nature and the Countryside Agency in England, and by the Countryside Council for Wales in Wales. There are a number of National and Local Nature Reserves, and Sites of Special Scientific Interest (SSSIs) where woodlands are an integral part of these designated areas, and, where landscape and recreation are important. Woodlands are also a significant visual component of the planning designations that may apply to these areas, such as National Parks and Areas of Outstanding Natural Beauty (AONBs).

6.5 Policy Delivery Co-ordination Mechanisms

Although not a requirement of the Forestry Acts, the Forestry Commission has increasingly consulted other statutory and non-statutory bodies in the formation of delivery mechanisms for forest policy.

6.5.1 National Forestry Strategies

There has been a gradual evolution in the way in which forest policy is delivered. Originally, there was a single approach, which applied to the whole of the UK. However, there was increasing recognition that the economic, environmental and social issues in England and Wales were different, and this resulted in the development of the England Forestry Strategy, following widespread consultation with statutory and non-statutory organisations. After devolution, a separate forest strategy was developed and approved by the Welsh Assembly.

6.5.2 England Regional Forestry Frameworks

The diversity of economic, environmental and social characteristics and issues relating to woodlands, and the ways in which woodlands can contribute to them, has been recognised by the Forestry Commission. They are now well-advanced in evaluating the regional value of woodlands and in identifying regional forest frameworks based on Government Regional Office areas in England. These regional frameworks are being devised as part of a well-prepared and planned consultation exercise with all interested parties. They are however not currently part of a Regional or Local Structure Plan and therefore, are not legal documents.

6.5.3 Policy Consultation Operational Arrangements

Prior to the planting or felling of most trees (refer to Section 6.4.1), the Forestry Commission follows a number of nationally agreed consultation arrangements in both England and Wales, and these provide an important mechanism for co-ordinating the delivery of government policies of the statutory organisations. The details of the consultation arrangements are given in Table 6.2 below.

Table 6.2 - Nationally Agreed Consultation Procedures Followed by the Forestry Commission for All Felling and New Planting Proposals

Relevant Statutory Body	Type of Case
English Nature Countryside Council for Wales	Planting or felling proposals that affect: • National Nature Reserves • SSSIs • Special Protection Areas • Special Areas of Conservation • Consideration is also given to applications for proposals adjacent to these special areas where there may be an effect
English Heritage CADW - Welsh Historic Monuments	Planting or felling proposals that affect: • Scheduled Ancient Monuments
National Park Authority	Planting proposals of 5ha or more in a: • National Park
Countryside Agency Countryside Council for Wales	Planting proposals of 5ha or more in a: • AONB • Heritage Coast
Local Authority	Planting proposals of 10ha or more: • Felling proposals that affect trees that are subject to a TPO or are in a Conservation Area
Agriculture Departments: Defra The Department for Environment, Planning and Countryside	When the land covered by the application is the subject of a management agreement under the Environmentally Sensitive Area scheme
England	
Defra	Any of the land covered by the application that has been given a grant by the Agriculture Department in the last two years
Countryside Agency	For new planting and felling proposals greater than 10ha in: • Environmentally Sensitive Area (inform ESA project officers) All felling proposals in: • AONB • Heritage Coast
Wales	
The Department for Environment, Planning and Countryside	New planting of: • 20ha or more • Where any of the land covered by the application has been given a grant by the Agriculture Department in the last two years
Countryside Council for Wales	All new planting or felling in: • Environmentally Sensitive Areas

These consultation procedures provide a clear mechanism for ensuring that economic, environmental and social issues connected with any changes in land use, or the landscape (new planting or felling), are identified and fully allowed for.

Should an applicant not be happy with any changes to their proposal requested by the Forestry Commission, they may appeal to the appropriate Regional Advisory Committee (RAC) whose members are appointed by the Forestry Commission under the Forestry Act 1967. The RAC seeks to reconcile the views of the parties concerned.

6.6 Summary of Future Trends and Drivers in the Forestry Framework

The future trends and drivers are likely to be:

- EU environmental legislation in relation to biodiversity, sustainability, water and soil (such as the Water Framework Directive, Environmental Liability Directive and Soils Directive);
- Country-based environmental and social legislation; and
- Regional and local delivery of government policy. This is already occurring with forest policy delivery in England, and in Scotland. Local Forestry Frameworks have been developed for sensitive river catchment areas.

The mechanism for consultation with other statutory organisations is already well established in relation to changes in the management of woodlands, and to land use changes through tree planting. Additional planting in accordance with a land use, or water catchment plan, will be feasible within the existing consultation arrangements.

6.7 The Nature Conservation Framework

6.7.1 Mechanisms Controlling the Nature Conservation Framework

The Wildlife and Countryside Act 1981 (as amended) is the primary mechanism for the legislative protection of wildlife in Great Britain. The Act is the means by which the EU Habitats and Species Directive, and Birds Directive are implemented.

The Wildlife and Countryside Act was amended by the Countryside and Rights of Way (CRoW) Act 2000, which strengthened the protection and management of SSSIs. Key provisions of the Act are:

- A power for the nature conservation agencies to devise management schemes for SSSIs in consultation with land managers, and to enforce these schemes where necessary;
- Measures to address damaging activities by third parties on SSSIs; and
- Increased penalties for offences relating to SSSIs.

As detailed in Section 4, key organisations within the flood management framework also have responsibilities with respect to nature conservation. For example, Sections 6 and 7 of the Environment Act 1995 set out the Environment Agency's general environmental and recreational duties. Similar duties are placed on drainage authorities through the Land Drainage Act 1994 (Environment Agency[b], Undated).

The English government's Public Service Agreement (PSA) is to get 95% of England's SSSIs (by area) into favourable or recovering condition by 2010. Nearly 60% of SSSIs are currently in a favourable or recovering condition (English Nature, 2003). Continued work towards the biodiversity targets set out in the national and local Habitat and Species Action Plans are one way of achieving this Agreement. Prescriptive targets

have not been set for SSSIs in Wales and Scotland. National Habitat Plans relevant to this study are detailed in Table 6.3 below.

Table 6.3 - National Habitat Plans Relevant to this Study (www.ukbap.org.uk)

Plan	Current Estimates of Area	Key Target
Wet woodland	50,000-70,000 ha in UK	Complete establishment of 3,375ha on unwooded sites or by conversion of plantations by 2015.
Lowland beech and yew woodland	No precise data in UK	Establish by colonisation or planting a further 1,500ha on unwooded sites or by conversion of non-native plantations by 2015.
Lowland wood-pasture and parkland	10,000-20,000 ha (in working condition)	In areas where derelict examples occur, initiate a programme to restore 2,500ha to favourable ecological condition by 2010.
Upland mixed ashwoods	No precise data in UK. Total extent estimated as 40,000-50,000 ha in late 1980s.	Complete establishment of 3,000ha on unwooded sites or by conversion of non-native plantations by 2010.
Lowland raised bog	Approximately 6,000ha in UK	Establish by 2005 appropriate hydrological and management regimes at those areas which have been damaged but still retain nature conservation interest.
Fens	Data not available	Initiate restoration of priority fen sites in critical need of rehabilitation by 2005.
Reedbeds	Approximately 5,000ha in UK	Create 1,200ha on land of low nature conservation interest by 2010.
Coastal and floodplain grazing marsh	Approximately 300,000ha in UK	Rehabilitation of 10,000ha and creation of 2,500ha by 2000.

Species Action Plans such as those for otter (*Lutra lutra*), water vole (*Arvicola terrestris*) and freshwater pearl mussel (*Margaritifera margaritifera*) etc. are also relevant. Funding for the management of SSSIs and Natura 2000 sites (Special Areas of Conservation and Special Protection Areas) is allocated from the budget given to the statutory nature conservation 'agency' for each country (refer to Section 6.7.2 below). Agri-environment schemes may also be utilised as funding sources (refer to Section 6.2.1). However, there is no dedicated funding instrument for nature conservation sites.

The Wildlife Enhancement Scheme, operated by English Nature, offers payments to land managers undertaking specific management prescriptions with agreed conservation objectives. The Scheme is intended as a mechanism for fine-tuning management on protected areas or for piloting special management requirements. Payments can be made on land already entered into agri-environment schemes, although double-funding is not permitted. Details of the Sheep and Wildlife Enhancement Scheme are provided in Section 7.

6.7.2 Key Organisations and Actors that Impact on Mechanisms

The statutory nature conservation 'agencies' (English Nature, Countryside Council for Wales and Scottish Natural Heritage) are charged with nature conservation, although the Countryside Council for Wales and Scottish Natural Heritage have roles wider than nature conservation. The Joint Nature Conservation Committee's main responsibility is to undertake Great Britain/UK international roles.

6.7.3 Summary of Future Trends and Drivers in the Nature Conservation Framework

The future trends and drivers are likely to be:

- EU environmental legislation in relation to biodiversity, sustainability, water and soil (such as the Water Framework Directive, Environmental Liability Directive and Soils Directive);
- Country-based environmental and social legislation; and
- Continuation of the current trend towards regional and local delivery of government policy.

7 SCOPE FOR INTEGRATION

7.1 Introduction

As shown in Section 5, there is still significant research and development required in relation to the impacts of land use and management practices on flood risk and extent (O'Connell *et al*., 2003). However, there is adequate evidence to begin examining the policy, regulatory, funding and organisational frameworks in England, Wales and Scotland, in order to identify opportunities for the integration of flood management with agriculture, biodiversity and forestry. This section is the start of that process.

Barriers to, and opportunities for, integration are outlined and discussed in terms of the following parameters:

- Policy;
- Regulation;
- Funding; and
- Organisation.

7.2 Policy: Barriers and Opportunities for Integration

7.2.1 Barriers

Common Agricultural Policy
The Common Agricultural Policy (CAP) arrangements were designed to provide maximum revenue and maximise production of various crops and livestock (refer to Section 6.2.1). They were not designed to address issues such as impacts of land use management changes on water management. Despite ongoing CAP reform there remain a number of barriers to changing land management at the farm-scale with the express aim of achieving flood management mitigation.

Although current agri-environment schemes, developed through the modulation of CAP funds to Pillar 2, are not aimed specifically at delivering flood management benefits (tending to concentrate on biodiversity, landscape, heritage and amenity/access) some schemes will indirectly support good practice in terms of grazing, stocking and land preparation. Unfortunately, these are not necessarily placed in the optimum areas of the catchment where they will have greatest mitigating impact. In addition, the existing CAP arrangements result in barriers to woodland expansion and management of woodland on farms and at least, in terms of woodland planting, it is likely that CAP reform will result in new barriers. These barriers are discussed below.

Box 1. Barriers to Achieving Flood Management Mitigation on a Farm-scale

- The capital value of agricultural land is kept artificially high by production subsidies;
- The Integrated Administration and Control System (IACS) deters farmers from changing land use once registered; and
- Livestock (headage) subsidises which encourage high stocking rates and, latterly extensification payments which have encouraged more extensive grazing systems, which in areas of high stocking density led farmers to maximise forage areas. (Land Use Policy Group and Forestry Commission, 2004).

Native woodland expansion is a priority for Biodiversity Action Plans (BAPs), however to date there has been limited progress for upland mixed ashwoods, lowland beech and yew trees, and wet woods. Continued steady expansion is required to meet these BAP targets, although unless some agreement can be reached with regard to the Single Farm Payment/cross-compliance, woodland expansion could be largely halted (Woodland Policy Group and the Forestry Commission, 2004).

The existing Woodland Grant Scheme (WGS) and forest and woodland planting schemes have had variable success in attracting farmers to create woodlands. In England, significant areas have been funded by the Forest and Woodland Premium Scheme, although in Wales the area is significantly less. One major disincentive for farmers is the administrative difficulty of amending the IACS and entering into a WGS. The main administrative problem is that the various regimes (agriculture, forestry etc.) operate from different sets of maps and when land is planted up and then ceases to be in agricultural use, the registration as 'forage area' needs to be deleted and the area eligible for subsidy payment re-calculated. Difficulties arise when the WGS map and the IACS map do not correspond. The perception of this problem is a significant deterrent to farmers. Currently, CAP reform seems likely to reinforce this barrier (Woodland Policy Group and the Forestry Commission, 2004).

7.2.2 Opportunities

The catchment approach underpins a number of further recommendations, which are detailed below.

Catchment Flood Management Plans
As detailed in Section 5, it is not just the individual land use or land management practice that may affect the flood risk or extent, it is the land use pattern and spatial variation within the overall catchment. This means that significant changes to flood risk and extent through changing land use and management can only be realised through adopting the catchment approach, i.e. identifying risks and opportunities on a catchment basis.

Catchment Flood Management Plans (CFMPs) (refer to Section 4.5.3) are the proposed vehicle in which to identify catchment-based policies for land management as part of a strategy to manage flood risk and extent. However, the success of the CFMPs depends on the following:

- Modelling is critical and at the moment may not be sensitive enough to pick up impacts and changes from land use and management practices. However, current research is ongoing (refer to Section 3.3) and modelling methods will be continually refined.

- There are no mechanisms in place to ensure catchment-based policies for land management are implemented (refer to Section 7.3). This is a fundamental gap in policy and regulation.

- Ongoing monitoring of land use change in the catchment and its effects on flood risk should comprise a key element of future flood predictive work.

Consultation and formal links to stakeholders and other agencies during the CFMP process is vital. The proposed list of stakeholders is wide and includes Forestry Commission, Farming and Wildlife Advisory Group, National Farmers Union and Local Planning Authorities. Consultation is at four stages from inception to dissemination. In addition, a Strategic Environmental Assessment (SEA) will be carried out for each CFMP in order to assess the cumulative impacts of each set of CFMP policies. This will ensure that impacts on biodiversity, landscape and recreation are assessed.

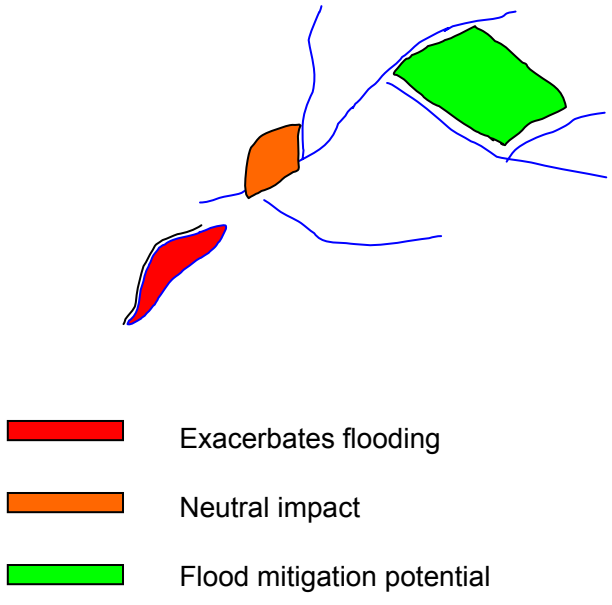
At present, there is no direct mechanism by which the findings and recommendations of CFMPs can influence the development of agri-environment priorities and schemes. In the future, CFMPs should be used to directly inform agri-environment priorities in those catchments which would benefit from changes to land use and management.

In order to distinguish areas where benefit can be realised or risk can be minimised, the CFMP process (refer to Section 4.5.3) should identify key areas of risk, which will allow the targeting of delivery mechanisms such as:

- Agri-environment schemes (for woodland planting, riparian zones, etc.); and
- Advice and best practice (for cropping type, timing and pattern, land preparation and drainage etc.).

For example, the following high (red), medium (orange) and low (green) risk approach to land use and land management practices in a catchment could be taken and visually presented as shown in Figure 7.1 below.

Figure 7.1 - Risk Approach to Land Use and Land Management Practices



Synergy with the Water Framework Directive
CFMPs could be integrated with diffuse pollution assessment (sediment aspects), in preparation for the Water Framework Directive. In the long-term, this will allow the development of a substantial synergy, for example in terms of data collection, modelling, consultation and recommended measures.

CFMPs are currently non-statutory plans and will link to other plans (refer to Figure 7.2 in Section 7.5.2). However, it is also recommended that there is a link to:

- Forestry Strategies - England/Wales/Scotland;
- Indicative Forestry Strategies;
- Forestry Frameworks; and
- Rural spatial plans (refer to Section 7.3.2).

In order to ensure CFMPs achieve multiple objectives, and influence other policy areas, targets or Key Performance Indicators could be set at the beginning of the CFMP process, such as contribution to BAP targets or changes in soil/organic matter.

Ongoing CAP reform
Historically, the methods of land management and cropping have been geared towards maximisation of production. However, with CAP reform focusing on resource management and not production, these barriers will start to be broken down.

Multiple benefits must be at the heart of any future agricultural management strategy. For instance, it will not be efficient or effective to apply changes to the Rural Development Programmes (RDPs) to allow payments for farmers to contribute to the delivery of flood management if payments for measures to tackle diffuse pollution are excluded (and vice versa). At the same time, other benefits and impacts should also be considered. Farmers must be offered an integrated package that meets the requirements of all existing and forthcoming EU directives and drivers, and is economically viable. Most importantly, this should be supported by access to specialist advice and training.

An EU working document on the Water Framework Directive and tools within the CAP (2003) has identified several areas of opportunity for the integration of flood management with CAP reform. These opportunities are discussed in detail below.

With respect to the next financing period, Member States could target a number of areas, which could bring benefits for flood management through farm management. These include:

- Provision of special training on the interaction between agricultural practices and water friendly environmental management to farmers in sensitive areas;

- Implementation of specific agri-environment measures to support the objectives of the Water Framework Directive. For example, to target erosion and run-off issues which could be expanded where appropriate to include further measures to slow down or reduce run-off;

- Marketing goods as ‘water friendly’ or ‘flood friendly’ comparable to current ‘eco-friendly’ labels;

- Provision of support/incentives for prioritising appropriate afforestation or woodland management in sensitive areas for the Water Framework Directive or flood management; and

- Use early retirement aid to re-assign agricultural land to non-agricultural uses where it cannot be farmed under satisfactory conditions of economic viability. This could be used for the Water Framework Directive in protection of wetlands but also for flood mitigation benefits, and land banking or floodplain restoration.

The drafting of codes of good farming practices for agricultural production under rural development, and river basin management planning under the Water Framework Directive will need careful alignment with respect to water related issues to come to common regional codes. In addition to this, the ELS Tier 1 of England and Wales will preferably contain, or need to be reviewed, to ensure that they contribute in terms of water and flood management.

Sustainable land management strategies, as described in Section 5.5, will be further promoted under CAP reform (refer to Section 6.2.2). However, there is a need to ensure awareness is raised with farmers and land managers on what measures they could adopt or plan for to mitigate flood risk from their land.

One measure, which could be considered, is set-aside on high risk land (identified through the CFMP process). This could be achieved through the Arable Area Payment Scheme (AAPS) (refer to Section 6.2.1). The AAPS allows farmers to claim area payments for taking land out of production as set-aside. The AAPS is due to be replaced by a new scheme in 2005.

This is also supported by a recommendation in the Environment Agency and English Nature strategy on diffuse pollution (confidential), which recommends that CAP reform proposals need to put in place a mechanism for mandatory set-aside for land located in areas of high pollution risk on the farm (not currently a condition). This should also be an option for areas of high flood risk.

The strategy also recommends that agri-environment funds need to be available for higher cost practical measures to address diffuse pollution on high risk land focused on priority catchments. This could include reversion of arable to pasture, the restriction of crop types and the adoption of other water sensitive measures to reduce run-off and erosion. The same approach could be used on areas identified as being of high flood generation risk.

In the development of entry level or other agri-environment schemes, the following should be considered:

- Encouraging sustainable land management strategies in pastoral grazing areas and in the riparian zone (for example moving livestock regularly, decreasing stocking rates, and improving soil management);
- Regeneration of vegetation/habitat restoration (for example native woodland and other vegetation) in ‘hot spot’ areas;
- Selecting the most appropriate grasses and legumes;
- Encouraging organic farming;
- Reversion (preferably permanent in high risk areas) to semi-natural vegetation;
- Establishing riparian zones (Section 5.2.7);
- Selecting earlier cropping varieties (thereby reducing bare ground);
- Mitigation for soil erosion;
- Maximising soil organic matter content, and protection of soil structure;

- Woodland planting; and
- Regulation (such as restricting crop types).

Member States therefore have the opportunity to use 'CAP tools' to deliver/integrate the Water Framework Directive, and to create flood management benefits by:

- Using flexibility in implementation of entry level or other agri-environment schemes in favour of water management and soil protection;
- Providing farm advisory services to address issues of relevance to the Water Framework Directive and flood management; and
- Drafting and implementing clear criteria for meeting good agricultural and environmental condition.

In addition, a review of agri-environment schemes in terms of socio-economic incentives i.e. shepherding (type of management), should be carried out. For example, the Sheep and Wildlife Enhancement Scheme (SWES) (refer to Section 6.2.1). The SWES will operate in 2004 with the intention to primarily focus on the lowlands. The wider adoption of such a scheme in areas of England, Wales and Scotland with grazing issues is a key opportunity. This would facilitate the re-establishment of effective shepherding in targeted areas of the catchment, which may decrease flood risk and extent.

In terms of woodland schemes, further work is needed on how easy it is for, and how likely it is that, land managers will remove land from the agricultural subsidy regime and enter into a WGS.

Finally there are several opportunities that have been identified through the comparison of policy in England, Wales and Scotland. These are detailed below.

- In Wales, an amendment to the RDP has been submitted to allow a pilot catchment-based agri-environment scheme. There is potential for this to be mirrored in England and Scotland.

- Scotland's Rural Stewardship Scheme (RSS) offers options such as management of wetland, creation of wetland, management of water margins, management of floodplains and creation of ponds. These options should be expanded and included in schemes in England and Wales.

- Early proposals for a higher tier scheme in Wales include actions to reduce flood risk. In addition, a Resource Management Plan (soil, water, nutrients and pesticides) is now seen as the core of the Welsh ELS. Similar actions should be incorporated into the appropriate level schemes in England and Scotland.

Under decoupled payments, there is no longer the requirement to farm in a particular way, as long as the cross-compliance requirements are met. The fact that the Single Farm Payment will be tradable is also important (Ward, 2003), although the implications will be different for England and Wales.

In Wales, a high proportion of farmers are over 50, and many have no obvious successor. It is therefore possible that some will opt to significantly scale back their agricultural activities. In this case, a number of opportunities may be opened up including:

- Managing the land under a flood alleviation scheme;
- Selling the land and entitlement to the Single Farm Payment (the farmer would then benefit from the capital value); and
- The purchase by land-owning bodies, such as the major environmental Non-Government Organisations.

Proposed EU Liability Directive
The EU proposal for an Environmental Liability Directive was published in January 2002 (refer to Section 4.3.5). The 'polluter pays' concept could be extended to 'flooders finance' in the event that contributors to flood risk are unwilling to change their management or regime. This is a similar concept to water pricing and paying for water use in drought periods

Integrated washland policy
There needs to be a full integration of washland policy including biodiversity, water quality, recreation, water resources, flood management and sustainability into measures (refer to Sections 1.4.1 and 1.4.2).

7.3 Regulation: Barriers and Opportunities for Integration

7.3.1 Barriers

Farm-scale regulation
On a farm-scale, there is no existing mechanism to regulate land managers in terms of positive water management i.e. achieving dynamic objectives for nature conservation, agricultural production and flood management unless a discharge consent or abstraction licence is required. In some instances, a voluntary Water Level Management Plan may have been agreed for a protected site (Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) or Special Area of Conservation (SAC)).

In principle, a Water Level Management Plan provides a means by which the water level requirements for a range of activities in a particular area (including agriculture, flood defence and nature conservation) can be balanced and integrated. However, a number of criticisms have been levelled at the plans such as their failure to 'challenge the status quo' and hence, highlight strategic and innovative approaches to land and water management.

In addition, although drainage is regulated within Internal Drainage Board (IDB) districts, outside these areas there is no regulation.

Catchment-scale regulation
On a wider catchment-scale, there is no strategic assessment, planning or cumulative assessment of the impacts of drainage or water level management. A number of local authorities in England and Wales have carried out strategic flood risk assessments, which cover both rural and urban areas, and have proved to be a useful tool to feed into policy and planning decisions. Strategic flood risk assessments are not statutory.

Although IDBs have duties to exercise general supervision for all matters relating to land within their district, they have no specific duties for mitigating flood risk and extent on a catchment basis.

Although the Environmental Impact Assessment (EIA) Regulations apply to projects that involve changing use of land by bringing uncultivated land or semi natural areas into intensive agriculture, there is no regulation of land preparation, cropping or stocking and grazing outside funded schemes or protected sites (SSSIs, SPAs and SACs).

Regulation of forestry
In terms of forestry, both deforestation and afforestation are generally well controlled due to the need for an EIA for both activities. However currently the Environment Agency is not a statutory consultee under this process and again, the cumulative impacts of forestry and woodland activities are unregulated.

Development control
The Planning Policy Guidance Note (PPG) 25 on "Development and Flood Risk" (2001), and for Wales Technical Advice Note (TAN) 15, provide a framework to control the flood risk issues pertaining to new developments (refer to Section 4.3.6). These documents are primarily targeted at residential, commercial and industrial developments. The revised documents will continue to affect the way flood risks arising from new developments are managed. However, the shortfall is a lack of inclusion of rural land use change and development and how that may contribute to flood risk and extent.

In summary, some potential flood risk issues from forestry, and agricultural and similar rural activities are addressed during the planning process, where formal planning approval is required. However, there are many instances, for example the existing use of land management practices that increase flood risk and extent, when no control is exercised.

7.3.2 Opportunities

Development control
The review of both PPG 25 and TAN 15 should include a land use/rural module and direct reference to CFMPs in terms of the designation of high risk land and other land use management policies.

Strategic flood risk assessments should be made statutory and undertaken with a SEA. These would then provide a strategic overview of flood risk in an area and information from this could feed into Local Plans and other development control policy documents.

Rural planning
It is clear from the above that there is no regulation of rural land management or use, outside of the planning framework. A rural land use planning framework would benefit a variety of environmental issues, including the CFMP process. This could be addressed by the introduction of a rural planning system and a rural spatial plan, which would not only allow flood management benefits to be achieved through land use management, but also allow a mechanism to plan for other new agricultural and environmental relationships (including the Water Framework Directive and climate change), as well as monitoring and managing the impacts of CAP reform.

EIA Regulations
The EIA Regulations should be extended to include land preparation, cropping or stocking and grazing outside funded schemes or protected sites (SSSIs, SPAs and SACs). This process would enable consultation with the Environment Agency and the identification of flood and diffuse pollution risks.

7.4 Funding: Barriers and Opportunities for Integration

7.4.1 Barriers

There are three types of funding relevant to this study. Firstly, funding for land managers to manage water in terms of flood risk and extent more effectively, (for example land drainage, water storage or riparian zones). Secondly, funding for land managers to manage land in a way that does not exacerbate flood risk or extent, for example cropping regimes and sustainable land management practices (refer to Section 5.5). Finally, funding capital schemes, other than traditional flood defence, to achieve multiple benefits, (for example floodplain restoration, woodland planting and washlands).

Funding for land managers
There are limited options available for funding land managers to manage water more effectively, and manage their land in a way that does not exacerbate flood risk or extent. There are no schemes that directly provide funding for mitigation of flood risk and extent (refer to Section 6.2.1). In England, there are currently no funding schemes that directly support resource management for water benefits (refer to Section 6.2.1) with the exception of the AAPS (also applies to Wales and Scotland). In contrast, Tir Gofal in Wales also considers soil and water management as part of the integrated whole farm approach, but with the limitation that measures are not necessarily targeted at high risk areas. In both countries, the Organic Farming Scheme in England and Organic Aid Scheme (Wales) will indirectly contribute to benefits in terms of soil and water management.

In addition to this, there is a general lack of funding for effective shepherding, which could be indirectly affecting flood risk and extent (refer to Section 5.2.4).

Consideration should be given to the direct targeting of flood management budgets to fund land management changes that would be effective at mitigating flood risk, both in terms of changes to management and geographical location.

Funding capital schemes other than traditional flood defence to achieve multiple benefits
Under the Environment Agency's flood and coastal defence budget, funding is available for flood storage, floodplain restoration or washland schemes. Within the existing flood defence funding arrangements in England and Wales, there are three options for the implementation of these types of schemes. Firstly, land purchase which is rarely feasible as the cost of land has to be included in the scheme's cost benefit assessment, this usually results in the scheme being uneconomic. The second option is to purchase flood easements or to lease land, which makes the scheme more viable economically as compensation to landowners is outside the cost benefit assessment. The third option is compulsory purchase, which is rarely initiated.

In addition, in terms of the timescale, the implementation of a floodplain restoration or washland scheme takes much longer than a traditional flood defence scheme and the process is often cumbersome and expensive due to multiple landowner involvement.

The flood defence budget is not set up to deliver multiple benefits and there are no separate biodiversity funding sources apart from scheme or project -specific funding. In addition, the cost benefit assessment (Flood and Coastal Defence Project Appraisal Guidance), in practice, has limitations in terms of tangible environmental and social benefits, or costs of other less favoured options.

Agri-environment funds cannot currently be used for water management on a catchment-scale, which is where most benefit in terms of flood risk and extent and multiple benefits may be realised. However the proposed Level 3 (top tier) of Tir Gofal (Wales) may allow for catchment-based prescriptions, through collective applications by all farmers in a catchment. In addition, agri-environment schemes are usually 10 year agreements and do not allow for large capital payments such as purchasing land.

There remains pressure to protect high value crops from flooding, whereas their removal and conversion to floodplain may contribute to significant reduction in flood risk. There are also problems with unsupported crops as there is no opportunity for change.

Biodiversity funding
With the exception of funding for the management of protected sites and funding for individual projects, there is currently little funding for biodiversity, particularly of a scale that would make an impact at a catchment level. This is a contributing factor to the ongoing failure to meet many BAP targets.

7.4.2 Opportunities

Flood and coastal defence funding review
Block funding is one of the main recommendations from the Department of the Environment, Food and Rural Affairs' (Defra's) and the Welsh Assembly Government's (WAG's) flood management funding review. However, the way in which block grant is allocated is important. It is therefore recommended that block funding is allocated so it is accessible on a catchment wide basis (refer to Section 7.5.2).

It is also important to ensure the flood management budgets can be used for capital schemes other than flood defence and engineering, for example woodland planting, set-aside, washlands and farm-scale management.

The existing appraisal guidance insufficiently considers environmental and social costs and benefits, as well as the sustainability factor for schemes such as storage areas or floodplain restoration schemes. It is recommended that the appraisal guidance is reviewed to take these factors into account more equitably.

In addition a more strategic, long-term view would include a mechanism that allowed land banking. There is a need for a mechanism that would allow the Environment Agency (or other operating authority) to land bank and land swap on a catchment wide basis. This would require funding and approvals to be more flexible and not scheme-specific or short-term.

The Flood and Coastal Defence Funding Review (refer to Section 4.5.2) has already suggested measures to amalgamate, and enhance the organisational and management practices of IDBs. This is mainly in terms of biodiversity benefits, although there is further opportunity to increase awareness and technical skills amongst land managers in terms of the impacts of drainage and water level management on flood risk and extent within the catchment.

Use of national envelopes
National envelopes, as detailed in Sections 6.2.1 and 6.2.2, could provide the opportunity to encourage more environmentally friendly farming practices. There is potential scope for greater use of these funding sources in terms of a combination of water management purposes including sustainable land management practices and the Water Framework Directive.

Health and wellbeing funding
Further research into the potential indirect health benefits of biodiversity, forestry, and wetlands etc. should be undertaken. If, as initial work suggests, the results are positive, government funding for health and well-being could be channelled through forestry or wetland projects. Green gyms for example, would achieve multiple benefits and potential reduced spend for the National Health Service. Recognition and joint funding should be sought for wider public benefits including recreation, health and mental wellbeing (through 'green gym' and health walks), and education, and integrated into capital schemes. At the moment, there is little incentive or available funding for the Environment Agency to do this.

Funding incentives
Tax breaks for capital allowances for environmental investments could be utilised to reduce flood risk and extent, i.e. purchasing land for floodplain restoration.

Integrated funding
As detailed in Section 7.5.2, it is proposed that funding sources in terms of agri-environment, flood management and biodiversity should be integrated. This would allow greater efficiency, less bureaucracy and achievement of multiple benefits.

7.5 Organisation: Barriers and Opportunities for Integration

7.5.1 Barriers

The organisational frameworks for flood management, forestry, agriculture and biodiversity are complex, and are different in England, Scotland and Wales (refer to Sections 4 and 6). There is also a lack of clarity with respect to the delivery of services. This presents barriers to delivering an integrated catchment approach to flood management, i.e. with agriculture, biodiversity and forestry in the following ways:

- Limited scope of individual organisations;
- Culture within organisations; and
- Lack of integrated land and water management.

For example, IDBs work in combination with the Environment Agency under the Land Drainage Act (1994) but opportunities for them to deliver multiple catchment effective benefits are limited, for example little on biodiversity. Their primary purpose is to drain

land for agricultural purposes within a drainage district. They will take into account adjacent IDBs and designated conservation sites, although their scope does not extend to consideration of the consequences of their actions on a catchment wide basis.

In terms of culture, floodplain restoration as a flood defence scheme is currently promoted by Environment Agency Flood Defence Engineers, who are supported by an Environment Agency Conservation Officer/Environmental Impact Assessment Officer and external stakeholders. The skills needed to successfully promote these schemes may however be land management, hydrology and stakeholder facilitation, and teams should be led by process managers rather than technical staff.

Land managers and organisations that regulate and advise re: land management may not fully understand or be aware of the links between farm-scale soil and water management, and consequential impacts on flood risk and extent. There is also a lack of technical hydrological knowledge amongst land managers, regulators and advisors. In addition, land managers will not necessarily feel a sense of responsibility or ownership of their contribution to catchment-scale impacts.

Loss of effective shepherding and the sustainability of rural living (including in-migration of urban dwellers and reduction in the rural labour force) exacerbate this situation in many areas.

7.5.2 Opportunities

Lord Haskins' rural delivery review for England
Lord Haskins' Rural Delivery Review for England advocated a more integrated approach to sustainable land management (refer to Section 1.1). An integrated agency is proposed to promote the sustainable use of land and the natural environment through the merger of English Nature, Defra's Rural Development Service (RDS) and some functions of the Countryside Agency. The remit of the integrated agency is likely to embrace biodiversity, historical landscape, natural landscape, natural resources, access and recreation.

The first steps to implement these proposals are only just being taken, however, it is clear that one of the potential shortfalls of the recommendations are that the delivery of integrated services for land and water may be difficult to achieve. Implementation of the proposals should provide a clear delivery mechanism for land management based activities that impact on hydrological processes, which can then cause diffuse pollution or exacerbate flood risk. The French experience shows the clear benefits of integrating land and water at the delivery level (refer to Box 2 below).

Box 2. French Experience

France has a history of integrated river basin management (www.environment.gouv.fr/dossiers/eau/PAGES/POLITIQUE/knowing/13a.H…). The Water Law of 1964 set out the main principles of water management in France. In each of the six large river basins, a State body, the Water Agency (Artois-Picardie, Rhin-Meuse, Seine-Normandie, Rhône-Méditerranée-Corse, Loire-Bretagne and Adour-Garonne basins), is responsible for ensuring the fair allocation of water resources in relation to economic development and environmental requirements.

The Water Agency depends on a river basin committee comprising local State representatives, users (manufacturers and farmers) and associations (conservation organisations and anglers). Each agency develops a SDAGE (Master Plan for Water Development and Management), a planning tool created by the Water Law of 1992 which sets out the main orientations of the river basin committee. The programme establishes the priorities for action for five years and their funding. Technical assistance and financial incentives are used to assist users to conserve aquatic environments, manage water and combat pollution. The funding is derived from fees paid by the user according to water used and pollution generated.

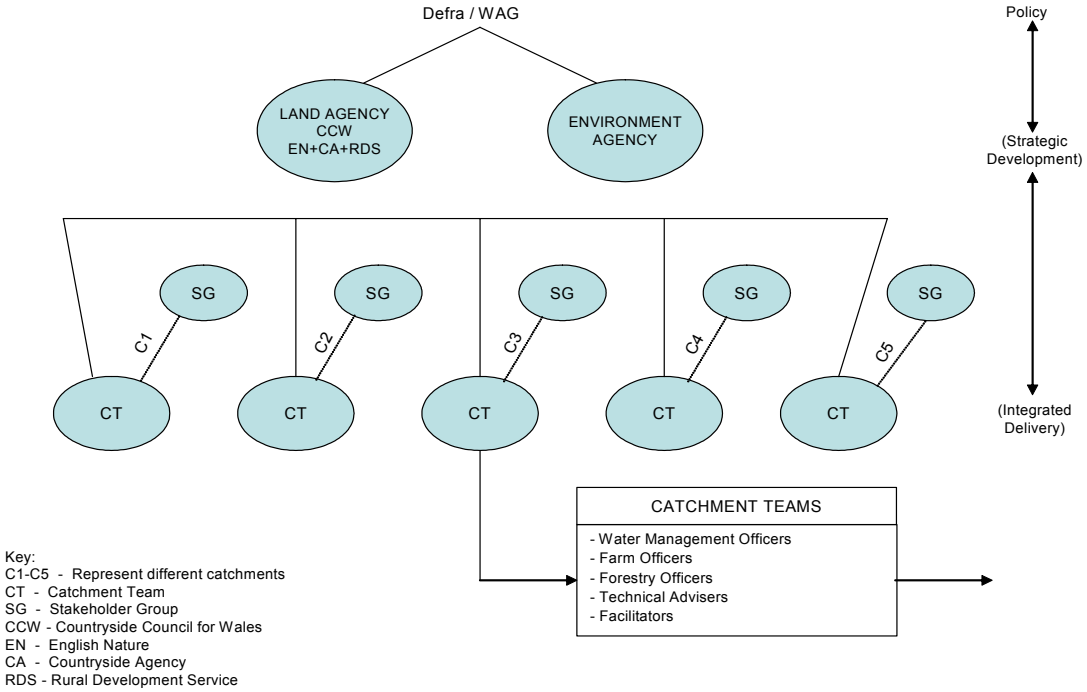
At a national level, The Ministry of Ecology and Sustainable Development integrates the actions carried out in each catchment area. The National Solidarity Fund was created recently to assist in this trend. This finances research in other fields to gain better knowledge.

Creation of catchment teams

Lord Haskins report goes some way to examining the integration of services, although, in order to achieve a full integration of flood management (or control of diffuse pollution) with agriculture, forestry and biodiversity, joined-up action needs to be undertaken for land and water interface services at the delivery level. No single organisation is currently in a position to deliver the necessary commitments, or access adequate funding, to realise these aims. It is recommended that members of staff from each of the delivery organisations are committed to form a ‘catchment team’ which can plan both the delivery of integrated actions and act as main points of contact in each organisation. Refer to Figure 7.2 below.

Figure 7.2

Proposed Organisational Structure



The concept of catchment teams (with duties and budgetary responsibility for integrated water and land management issues including drainage, diffuse pollution, run-off control, establishment of washlands, any water resource and quality issues arising from land management, flood management, biodiversity, nature conservation and forestry) having access to the powers vested in all contributing agencies would have the following benefits:

- The creation of a catchment-wide budget would integrate existing 'piecemeal' funds to tackle land/water interface issues;
- The integration of land and water interface issues would facilitate the 'ecosystem approach' (refer to Section 3.2);
- Targets and Key Performance Indicators (KPIs) could be set for each catchment (these could link with BAP targets, agricultural and environmental condition or any of the targets established as priorities for that catchment);
- The structure would contribute to the implementation of the Water Framework Directive by delivering land-based measures required for compliance;
- It would provide a one-stop shop for land managers;
- It would harmonise at the delivery level some legislative requirements and policy; and
- It would allow catchment specific issues to influence priorities in terms of resources, funding, environmental protection etc.

The disadvantages and potential issues with the structure are that:

- Catchment boundaries do not follow administrative or organisational boundaries; and
- Administratively, it introduces a third tier of organisational responsibility.

Consultation and stakeholder groups
The Countryside Council for Wales recommended in its consultation paper to the WAG "Flood Defence Arrangements for Wales the Future", that a river basin stakeholder group is set up to facilitate the inclusion of local views for not only flood management issues, but a range of other water management issues including diffuse pollution, the Water Framework Directive, and abstraction. This is a proposal that would sit well with the above organisational structure. It would also increase efficiency and allow joined-up thinking and ownership of land and water management solutions.

Performance indicators for organisations
Defra and the WAG are currently reviewing performance indicators for the Environment Agency's flood management responsibilities. These should include social and environmental aspects with tangible targets such as direct contribution to BAPs. In addition, KPIs should be set for the new land management agency in terms of delivery of multiple objectives including water management issues such as flooding, the Water Framework Directive and diffuse pollution.

Flood appraisal groups
In Scotland, there has been the development of voluntary Flood Appraisal Groups (FAGS) under National Planning Policy Guideline (NPPG) 7 on Planning and Flooding. They have been successful in collating information, promoting information exchange between relevant bodies, and taking a more strategic approach by influencing flood policies and decision-making. However, the potential for these groups is not being maximised as it is bound into the planning system whose powers extend only to non-

agricultural land, not the catchment level, and have no statutory basis (World Wildlife Fund (WWF), 2002). WWF also suggests that the FAGS take on a statutory advisory role, with their remit covering all land uses within the sub-basin, and that there should be a national FAG to co-ordinate FAGS. In England, there are Flood Forums which adopt a similar approach, although are less developed.

Cultural change
The Environment Agency recognises that the resources need to be in place to implement the forthcoming Flood Risk Management Strategy. A series of actions in terms of recruitment are detailed. However, the skills and qualities that go to making up the team are fundamental. Those involved in decision-making should be forward thinking, process managers and facilitators with technical backup including key skills in hydrology, land management, and biodiversity, with less emphasis on 'hard' engineering. The team would also need access to tools to implement the policies including:

- Drainage control;
- Land use change;
- Catchment modelling;
- Engineering;
- Flood warning; and
- Development planning.

Facilitating change in land managers
The attitude/knowledge and skills of a land manager are some of the key barriers to implementing multiple objectives. Projects such as the Countryside Agency's programme of nine Land Management Initiatives (LMIs), the Wise Use of Floodplains work, and the Parrett Catchment (refer to Sections 5.4.1 and 5.6.1 respectively) could be used as best practice in terms of facilitating change in attitudes and farm practices.

The need for cultural change requires education and must come from the officers on the ground delivering the agri-environment schemes, or other organisations that have direct contact with land managers such as the IDBs.

Farming advisory services
The report of the Policy Commission on the Future of Farming and Food (2002) proposed a farming advice line to sign-post farmers to the best advice currently available. It was envisaged that this would act as a front-end to existing government-sponsored services and a gateway to the advisory functions of other bodies.

Farming Connect is a provider of services to the farming community in Wales (refer to Section 6.2.3 for details). Its primary purpose is to support the delivery of Farm Business Development Plans (FBDPs), which now have the potential to include an Environmental Opportunities Review. The FBDPs are delivered by independent consultants, with the costs paid by Farming Connect, and largely funded via Objective 1. FBDPs are a gateway to capital grants, although this was not the primary purpose of the scheme. There is the intention to adapt Farming Connect so that it can take on the role of the farm advisory service included in the CAP reform package. This concept should also be implemented in England and Scotland.

7.6 Operational Opportunities

In addition to strategic opportunities, this study has identified several operational opportunities for implementation in the short-term.

- A review should be undertaken of the Environment Agency's Best Management Practices in terms of flood management. This review could be combined with a review of best management practice for mitigation of diffuse pollution.

- Most established tools available for assisting land managers with farm planning are related to nutrient management and not physical soil protection. The tools should be revised to include measures for flood risk and physical damage to soil.

- R&D project package 2.4 (refer to Section 3.3) will produce a specific deliverable from the land use management programme *"short term guidance to Defra/Environment Agency on upland land management in terms of contribution to flood risk".* This should be used to inform ongoing policy reform particularly CAP reform.

- A review of existing Environment Agency guidance re: washlands/floodplain restoration is recommended, including environmental economics, available funding sources, washland design for biodiversity benefits and worked examples of cost benefit. This should be produced as a best practice manual.

- A review of current guidance in terms of designing riparian zones within forests and buffer areas at the end of internal woodland drains should be undertaken.

7.7 Key Recommendations

Key recommendations are detailed in Table 7.1 below.

Table 7.1 - Key Recommendations

POLICY
Opportunities
Opportunities under ongoing CAP reform include: • Integrated approach for future agri-environment schemes including all new legislation (diffuse pollution, Water Framework Directive and flood management); • Set-aside on high risk land identified through CFMP process (could be achieved through AAPS) could be made mandatory; • Agri-environment funds should be made available for higher cost practical measures; • CAP tools should be used to deliver flood management benefits by using flexibility in implementation of entry level or other agri-environment schemes in favour of water management and soil protection; • Procedures for farmers removing land from the agricultural subsidy regime to a WGS should be reviewed; • Agri-environment schemes should be reviewed in terms of social-economic incentives, i.e. shepherding; • England and Scotland should mirror Wales in the development of a pilot catchment-based agri-environment scheme into the RDP; • The Entry Level Scheme (ELS) Tier 1 of England and Wales should preferably contain, or need to be reviewed, to ensure that they contribute in terms of water and flood management; • England and Scotland should mirror Wales' proposals for a higher tier scheme to incorporate actions to reduce flood risk, and a Resource Management Plan forming the core of the ELS; • Land managers should be supported by advice and training with respect to agricultural practices and water friendly environmental management;

POLICY
Opportunities
• CFMPs In particular: KPIs should be set for CFMPs; CFMPs could be integrated with sediment aspects of diffuse pollution (data collection, modelling, consultation and recommended measures); and CFMPs should be linked to other plans including National Forestry Strategies, Indicative Forestry Strategies, Forestry Frameworks and Rural Spatial Plans (see below). • There should be full integration of washland policy including biodiversity, water quality, recreation, water resources, flood management and sustainability into measures.

REGULATION
Opportunities
• EIA regulations should be extended to include land preparation, cropping or stocking and grazing outside funded schemes or protected sites; • Make Strategic Flood Risk Assessment statutory (accompanied by Strategic Environment Assessment); • CFMPs; • Environment Agency should be statutory consultee on deforestation and afforestation projects under EIA Regulations; • Review of PPG 25 and TAN 15 should include a land use/rural module; and • Bring agricultural land management into the planning and consultation process through the introduction of a rural land use planning framework, rural planning system and rural spatial plan.

FUNDING
Opportunities
• Refer to CAP reform; • The flood and coastal defence funding review should ensure flood management budget can be utilised for capital schemes other than flood defence and engineering, for example, woodland planting, set-aside or farm-scale management; • Block funding should be allocated on a catchment basis; • Use of national envelopes for land and water management; and • Tax breaks for capital allowances for environmental investments should be utilised to reduce flood risk and extent i.e. purchasing land for floodplain restoration.

ORGANISATION
Opportunities
• Members of staff from each delivery organisation (Environment Agency, English Nature, Forestry Commission, IDBs, Defra) should form a 'catchment team' (refer to Figure 7.2) with duties and budgetary responsibility for integrated water and land management issues including forestry, drainage, diffuse pollution, run-off control, flood management, water resource and quality, biodiversity, and agriculture; • Each catchment team should have KPIs and targets to achieve multiple benefits; • Recruitment of process managers and facilitators, as well as technical staff to deliver multiple benefits efficiently; • Creation of land and water management stakeholder groups (refer to Figure 7.2); • Projects such as the Countryside Agency's programme of Land Management Initiatives and the Wise Use of Floodplains Project should be used as examples of best practice; and • Similar approaches to Wales' Farming Connect should be implemented in England and Scotland.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

- Whilst it is recognised that research with respect to rural land use and flood generation is currently ongoing, it is generally expected that the effect of rural land management on flood risk will be more significant for smaller rainfall events, reducing as the events approach extreme events.

- It is possible to identify a number of key mitigation measures that will reduce flood risk and extent at the field-scale (for example good soil husbandry, woodland creation, washland creation). However, the catchment-scale impacts of a widespread increase in infiltration need to be assessed.

- At present, modelling is not sensitive enough to identify impacts and changes from land use and management practices. However, current research is ongoing and modelling methods will be continually refined. The results of such modelling need to be used to inform ongoing policy reform.

- There is currently no existing 'vehicle' for input into strategic flood management/decision-making from other organisations.

- The Water Framework Directive and reform of the Common Agricultural Policy are key drivers in all policy areas, and integrated solutions for reducing flood risk and extent need to fully utilise these opportunities.

- Multi-use wetlands and woodlands in appropriate locations offer the potential to reduce flood risk and extent, while benefiting certain agricultural/forestry crops (willow production), nature conservation and recreation.

- In the long-term, the development of catchment teams could drive the river basin management process.

8.2 Recommendations

Key recommendations in relation to the integration of agricultural, forestry and biodiversity conservation policies with flood management are detailed in Section 7. In addition, the recommendations highlighted in O'Connell *et al*. (2004) should be progressed and used to inform ongoing policy reform. These recommendations include:

- More information is required on land management practices across the UK to combine with soil conditions, climate and topography to identify catchment areas at risk.

- Multi-scale monitoring studies are needed to assess the transmission of impacts from the local to the catchment -scale.

- Research is required to better understand how different catchments are likely to respond under future climatic conditions. This should be linked to socio-economic change scenarios i.e. land manager responses to climate and policy changes.

It is also recommended that this report is disseminated to relevant staff within the Department of the Environment, Food and Rural Affairs, Welsh Assembly Government and Scottish Executive.

REFERENCES

Acreman, M. 2003. The Impact of Floodplain Restoration on Flood Hydrology. 38th Defra and Coastal Management Conference, Keele University, 16-18 July 2003.

Anon. Undated. Wise Use of Floodplains: Guidance Notes.

APEM. Undated. The Impact of Grazing and Upland Management on Erosion and Runoff. Research and Development Technical Report, P123. Environment Agency.

Babtie Group and Renfrewshire Council. Undated. Land-use Change and Flood Attenuation: The Predicted Benefits of Semi-natural Woodland. Ministry of Agriculture, Fisheries and Food Conference, 2000.

Bastani, B. Flood Response: Flood Defence Funding Review. Water and Environment Manager, May 2003. Chartered Institution of Water and Environmental Management.

Bird, S.B., Emmett, B.A., Sinclair, F.L., Stevens, P.A., Reynolds, B., Nicholson, S. and Jones, T. 2003. PONTBREN: Effects of Tree Planting on Agricultural Soils and Their Functions. CCW Contract Science Report No 550. NERC Centre for Ecology and Hydrology. CEH Projects C02321 and C02149.

Calder, I.R. 1999. The Blue Revolution: Land-use and Integrated Water Resources Management. Earthscan Publications, London.

Cambridgeshire County Council, Countryside Commission, Environment Agency, English Nature, Lincolnshire County Council and Royal Society for the Protection of Birds. 1996. Wet Fens for the Future. Royal Society for the Protection of Birds, Sandy, UK.

Coulthard, T. and Jones, A. 2002. Modelling the Relationship Between Land Cover and Hydrology in Welsh River Catchments. Institute of Geography and Earth Sciences, University of Aberystwyth. Report to Countryside Council for Wales.

Coulthard, T.J. and Macklin, M.G. 2001. How Sensitive are River Systems to Climate and Land-use Changes? A Model-based Evaluation. Journal of Quaternary Science, 16, 4, 347-351.

Defra. 2001. Shifting Support From the 1st to the 2nd Pillar of the Common Agricultural Policy (CAP). Background Policy Paper to Inform Workshop Discussions.

Defra. 2002. Flood and Coastal Defence Funding Review. Report on Outcome of Consultation. Defra, October 2002, London. www.defra.gov.uk.

Defra. 2003a. E-Digest of Environmental Statistics. Defra, September 2003.

Defra. 2003. Delivering the Evidence: Defra's Science and Innovation Strategy (2003-06). Defra, 2003, London.

Defra. 2003. Delivery Plan for Implementing the Conclusions of the Flood and Coastal Defence Funding Review. Defra, March 2003, London.

Defra. 2003. Our Strategy 2003-06. Defra, 2003, London.

Defra. 2003b. The First Soil Action Plan for England: 2004-2006. Defra, 23 October 2003.

Defra. 2003. Entry-Level Agri-Environment Scheme Pilot: Scheme Guidance Booklet. Defra, London.

Defra, English Nature, Forestry Commission and Environment Agency. 2003. Statement on Wetlands, Land Use Change and Flood Management.

DTLR. 2001. Planning Policy Guidance Note 25, Development and Flood Risk. DTLR, London, UK.

English Nature. 2001. The Upland Management Handbook.

English Nature. 2003. Key Messages. English Nature Magazine, July 2003.

English Nature. 2003. Sheep and Wildlife Enhancement Scheme: Sustaining Wildlife and Sheep Farming. Information Note 1: The National Picture. English Nature.

English Nature. 2003. Sheep and Wildlife Enhancement Scheme: Sustaining Wildlife and Sheep Farming. Information Note 3: The Scheme in Northumbria. English Nature.

English Nature. 2003. Sheep and Wildlife Enhancement Scheme: Sustaining Wildlife and Sheep Farming. Information Note 3: The Scheme in Cumbria. English Nature.

English Nature. 2003. Sheep and Wildlife Enhancement Scheme: Sustaining Wildlife and Sheep Farming. Information Note 4: The Scheme in Lowland England. English Nature.

Environment Act 1995. Chapter 25, Her Majesty's Stationery Office 1995, London.

Environment Agency[a]. Undated. Understanding Rural Land Use.

Environment Agency[b]. Undated. Policy and Practice for the Protection of Floodplains.

Environment Agency. 2002. The Parrett Catchment: Water Management Strategy Action Plan. Environment Agency, Exeter.

Environment Agency. 2003a. Catchment Abstraction Management Strategies (CAMS) and the Water Framework Directive (WFD). Briefing Note.

Environment Agency. 2003b. Strategy for Flood Risk Management (2003/4 – 2007/8). Draft version 1.1, www.environment-agency.gov.uk.

Environment Agency, Defra with Engineering and Physical Sciences Research Council, Natural Environment Research Council and UK Water Industry Research. 2003. Flood and Coastal Erosion Risk Management Research News, 4, July 2003.

Environment Agency and Lewin, Fryer and Partners. 2003. Parrett Catchment Flood Management Plan. Consultation Draft.

European Commission. 2003. The Water Framework Directive (WFD) and Tools Within the Common Agricultural Policy (CAP) to Support its Implementation. Working Document. Directorate-General Environment. Brussels, 21 November 2003.

Evans, E.P., Penning-Rowsell, E.C. and Hall, J.W. 2003. Foresight Flood and Coastal Defence Project: Phase 1 Technical Report Drivers, Scenarios and Work Plan. Office of Science and Technology, January 2003, www.foresight.gov.uk.

Forestry Commission. 2002. How We Consult About Woodland Planting and Tree Felling.

Forestry Commission. 2004. Forest and Water Guidelines.

Gilman, K. 2002. Land Use and Floods in the Headwaters of the River Severn. Report to English Nature.

Habiforum. 2002. Water Voor Ruimte, Ruimte Voor Water. Drukkerij Jubels BV. Amsterdam.

Haskins, C. 2003. Rural Delivery Review: A Report on the Delivery of Government Policies in Rural England. Defra, London.

Hollis, J.M. and Thompson, T.R.E. 2003. The Impact of Land Management on Soil Hydrology and Source Run-off. Proceedings of Land Use and Flood Management Conference, 30 January 2003. Institution of Civil Engineers Water Board, London.

Institution of Civil Engineers. 1996. Land Drainage and Flood Defence Responsibilities. 3rd edition, Thomas Telford, 1996.

Institution of Civil Engineers. 2001. Learning to Live With Rivers. Final Report of the Institution of Civil Engineers' Presidential Commission to Review the Technical Aspects of Flood Risk Management in England and Wales.

Jenkins, L. and Horrocks, R. 2002. Lessons Learnt From the Wise Use of Floodplains Project: An Environment Agency Perspective. Proceedings of World Wetlands Day Conference, London, 2002.

Land Drainage Act 1991. Chapter 59, Her Majesty's Stationery Office 1991, London.

Land Drainage Act 1994. Chapter 25, Her Majesty's Stationery Office 1994, London.

Land Use Consultants. 2001. The Parrett Catchment Project: An Action Strategy for Integrated Catchment Management.

Lewin, K. 2002. Water, Life and Culture: The Water Framework Directive. Proceedings of World Wetlands Day Conference, London, 2002.

Ministry of Agriculture, Fisheries and Food and Welsh Office. 1993. Strategy for Flood and Coastal Defence in England and Wales. Ministry of Agriculture, Fisheries and Food, 1993, London.

Ministry of Agriculture, Fisheries and Food. 1999 - 2002. Flood and Coastal Defence Project Appraisal Guidance FCDPAG 1,2,3,4 and 5. Ministry of Agriculture, Fisheries and Food, London.

Morris, J., Hess, T.M., Gowing, D.J., Leeds-Harrison, P.B., Bannister, N., Vivash, R.M.N. and Wade, M. Integrated Washland Management for Flood Defence and Biodiversity. Workshop Discussion Paper. Cranfield University (Silsoe), River Restoration Centre and Ecoscope.

National Soil Resources Institute. 2001. A Guide to Better Soil Structure. National Soil Resources Institute, Cranfield University, Silsoe, Bedfordshire.

Nisbet, T. 2003. Opportunity Mapping for Trees and Floods. Institute of Chartered Foresters News, 1.

O'Connell, P.E. 2003. Catchment Scale Hydrological Issues Relating to Land Use Management and River Flows. Proceedings of Land Use and Flood Management Conference, 30 January 2003. Institution of Civil Engineers Water Board, London.

O'Connell, P.E., Beven, K.J., Carney, J.N., Clements, R.O., Ewen, J., Fowler, H., Harris, G.L., Hollis, J., Morris, J., O'Donnell, G.M., Packman, J.C., Parkin, A., Quinn, P.F. and Rose, S.C. 2004. Review of Impacts of Rural Land Use and Management on Flood Generation. Part A: Impact Study Report. Defra/Environment Agency R and D Technical Report (Project FD2114).

Policy Commission on the Future of Farming and Food. 2002. Farming and Food: A Sustainable Future. January 2002.

Posford Haskoning and Royal Holloway Institute for Environmental Research. 2002. Northumberland National Park Land Management Initiative: Resource Management Project. Report to the Countryside Agency, North East Region.

Posford Haskoning and the Centre for Ecology and Hydrology. 2003. Review of Lake Restoration Techniques and Resource Costs. Report to English Nature, Peterborough.

Richardson, D. 2003. Wetlands, Washlands, Land Use and Flood Management. Proceedings of Land Use and Flood Management Conference, 30 January 2003. Institution of Civil Engineers Water Board, London.

Richardson, J., Björheden, R., Hakkila, P., Lowe, A.T. and Smith, C.T. eds. Undated. Bioenergy From Sustainable Forestry. Kluwer Academic Publishers, Dordrecht/Boston/London.

Rodwell, J. and Patterson, G. 1994. Creating New Native Woodlands. Forestry Commission Bulletin 12. HMSO: London.

Royal Society for the Protection of Birds. 2001. Submission to the Institution of Civil Engineers Presidential Commission to Review the Technical Approaches to Flood Risk Management in England and Wales, May 2001.

Scottish Executive. Undated. Organic Aid Scheme. Scheme Year 2003: Explanatory Booklet.

Scottish Executive Environment and Rural Affairs Department. Eds. 2002. Rural Development Regulation (EC) No 1257/1999: Rural Development Plan for Scotland.

Summers, D. 1994. Livestock and Stream Banks. Enact, 2, 4, 21-23.

Thorne, B. 2003. Farming Water in the Parrett Catchment. Proceedings of Land Use and Flood Management Conference, 30 January 2003. Institution of Civil Engineers Water Board, London.

UKWAS Steering Group. 2000. Certification Standard for the UK Woodland Assurance Scheme. Edinburgh.

Ward, J. 2003. Decoupling: An Outline Guide. FPDSavills Research. 4 November 2003.

Water Resources Act 1991. Chapter 57, Her Majesty's Stationery Office 1991, London.

Water UK. 2002. Diffuse Pollution, Floods and Farming. Water UK and RSPB Think Tank, 22 April 2002. Commonwealth Institute London.

Welsh, M. 2002. The Pyramid and 'The Broad and Shallow'. Wales Wildlife and Countryside Link Agriculture Group. Paper presented to the Minister for Agriculture and Rural Affairs.

Welsh Assembly Government. 2002. A Review of Agricultural Practices and Their Effects on Flooding in Wales. Welsh Assembly Government.

Welsh Assembly Government. 2003. Consultation on a New Approach: An Entry Level Agri-Environment Scheme for Wales. August 2003.

Willis, K.G. 2002. Benefits and Costs of Forests to Water Supply and Water Quality. Social and Environmental Benefits of Forestry: Phase 2. Report to the Forestry Commission, Edinburgh. Centre for Research in Environmental Appraisal and Management, University of Newcastle upon Tyne.

Woodland Policy Group and the Forestry Commission. 2004. CAP Reform (June 2003): Implications for Woodlands and Forests. 16 January 2004.

World Wildlife Fund. 2002. Turning the Tide on Flooding. World Wildlife Fund, Scotland. November 2002.

Worrell, R., Peterken, G., Scott, A., Pryor, S., Taylor, K., Knightbridge, R. and Brown, N. 2002. New Wildwoods: Developing the Role of Large-scale New Native Woodlands in the Uplands. Land Use Policy Group.

www.defra.gov.uk/environ/fcd/policy/strategy.htm. Strategy for Flood Management and Coastal Protection: Defra Update on Strategy Development, 19 August 2003. www.defra.gov.uk/environ/fcd/policy/ForumMtgs/28Nov2003/fmssf08.htm. Paper FMS/SF 08: Management of Flood Risk and Coastal Erosion, Development of Revised Vision, Aims and Objectives. Discussion Paper for Second Stakeholder Forum Meeting to Discuss Defra's Strategy for Flood Management and Coastal Protection, 28 November 2003.

www.wales.gov.uk/subienvironment/content/consultations/flood/flood-consult-e.htm. Flood Defence Arrangements in Wales, The Future: A Consultation for Option for Change for Wales, September 2003.

www.environment.gouv.fr/dossiers/eau/PAGES/POLITIQUE/knowing/13a.H…

APPENDIX A

CONSULTATION DOCUMENT

APPENDIX B

THE FORESTRY AND WOODLANDS POLICY FRAMEWORK

A major UK forestry policy development over the post-1990 period is the growing influence of international agreements and regulations on UK policy priorities and operational requirements, the emergence of EU funding and support for forestry and associated rural sectors and activities, and the devolution of forestry to the five country administrations. The most important of these international policy frameworks are:

- The 1992 United Nations Environment Programme Rio Conference, which identified forestry actions and requirements. These have been incorporated into UK policy through initiatives such as Biodiversity Action Plans at national and regional levels.

- The 1993 Ministerial Helsinki Conference on the protection of European Forests at which the UK Government committed itself to the sustainable management of its forests, followed by the 1994 Pan-European Criteria on the priorities for sustainable forest management. The UK also became a signatory to the 1998 Pan-European Ministerial Conference in Lisbon on the protection of forests.

- The UK, as a signatory to and participant in the 1999 UN Framework Convention on Climate Change, has undertaken to protect and enhance national and regional carbon sinks in forests and other biomes.

- Beginning in 1992 with the EU's "Community and Scheme for Forest Support Measures With Agriculture", and subsequently through the EU's 1999 Rural Development Regulation, EU funding has been made available via Defra to support forestry in England, and for Wales via the Welsh Assembly Government.

These international, European and domestic policy developments have had a major impact on forestry. However, European and domestic policies have not as yet specifically identified the relationship between forestry and flooding as a priority area. This is likely to become an increasingly recognised policy and operational issue, particularly given the nature of future climate change scenarios. It may well be that the EU Water Framework Directive will become the initial driver for relevant integrated land use policy initiatives in the UK.

The UK forestry policy framework has also become more comprehensive (and complex) over the course of the past decade, especially since the devolution of much Great Britain forestry policy, operational strategy and public forest management to the four nations of England, Wales, Scotland and Northern Ireland. This has led to four relatively independent and self-standing forestry policy frameworks, alongside the longer-established devolution to Northern Ireland. In all cases, the over-riding policy objective for the four national strategies is to pursue and ensure sustainable forest management.

Separate, though similar, Forestry Frameworks have been produced for each of the five UK nations. These have a common agreement in that it is important to ensure sustainable management of existing forests and woodlands; and where appropriate, to secure a continued expansion of national woodland areas to generate additional economic, environmental and community benefits. These national frameworks, devised through extensive stakeholder consultations, build upon earlier national forestry strategies promoted by the key forestry sector stakeholders (Forestry Industry Council of Great Britain (FICGB), 1987 and 1993). An important milestone in the evolution of a stronger policy consensus about the role, contribution and requirements of forestry came through The UK Forestry Accord signed by the FICGB and the Wildlife and

Countryside Link in London in November 1996. This agreement enabled the Forestry Commission and other stakeholders to evolve and introduce policy priorities that currently shape UK forestry policy, investment and management.

The UK Forestry Standard is the approach to sustainable forest management adopted across the UK and endorsed by all the devolved administrations in their Forestry Strategies. The UK Woodland Assurance Scheme (UKWAS) is a voluntary quality assurance standard, which is not itself a policy mechanism, although adoption of it by state forests across the UK has been. Progress against the UKFS criteria is now being monitored and assessed through the UK Indicators of Sustainable Forestry, which the Forestry Commission and key stakeholders began to publish in 2002. UKWAS is monitored via the certification body.

The principal water-related recommendations or management criteria for forestry and woodlands in the main UK policy and strategy statements to date are:

- "Forest management practices should have due regard to the protection of areas of ecological fragility, to the conservation of primary and climax forests, areas with cultural heritage, and the landscape, to safeguarding the quality and quantity of water, and to maintaining and developing other protective functions of forests such as the protection of aquatic and agricultural ecosystems and protection against floods, erosion and avalanches" (The Helsinki Guidelines, 1993; Section 6).

- "The sustainability of forest productivity and environmental values depends crucially on the conservation of biodiversity and natural resources such as soil, water and air quality" (UK Forestry Accord 1996).

- The UKFS requires that forestry and forestry operations are planned and undertaken in such a way that *"…..water quality is protected and improved, water yields are maintained above any critical level and water discharge patterns are disturbed only when unavoidable, and options have been explored"* (UK Forestry Standard, 1998).

This latter standard is currently the principal UK sustainable forest management requirement. The standard sets specific forest management unit indicators for water quality, yield and discharge patterns, and amongst the evidence of adherence to the Standard's water criteria are *"that all forestry operations are planned and undertaken to minimise disturbance to watercourses and to avoid pollution and siltation"*. There is no specific standard requirement to consider or address the impact of new planting and/or forest management on the flooding of watercourses and catchments.

Supporting the UKFS are the Forestry Commission's "Forest and Water Guidelines", which require that consultations with the water regulatory authorities address and reduce the impacts of forestry on water. The following statement is of relevance to this study:

"In responding to consultation on afforestation it is sometimes necessary for the water regulatory authority to take a strategic view of the cumulative impact of forests on individual water catchments and on downstream interests".

The Guidelines are currently under review.

APPENDIX C

Key Organisations and Actors that Impact on Mechanisms

There are essentially three major organisations with a statutory remit and role within the forestry sector in England and Wales: Department of the Environment, Food and Rural Affairs (Defra), the Forestry Commission, and the National Assembly for Wales with the latter having separate devolved policy priorities and strategies for Wales. In addition, the recently established Regional Development Agencies (RDAs) in England have increasingly active strategic and operational involvement with forestry and woodlands, while the Welsh Development Agency is more focused on timber and wood processing. In England, the new Government Offices for the Regions also have a forestry and woodland remit generally through the secondment of Forestry Commission or Forest Enterprise staff; and most Local Authorities have an active role in shaping forestry and woodland investments and management.

The Forestry Commission

The Forestry Commission England advises the English government on forestry matters in England, and the Forestry Commission Wales advises the Welsh Assembly Government on all aspects of forestry, woodlands and the related processing sectors. They are responsible for regulating and promoting sustainable forest and woodland management; for managing the majority of the public forest estate in each country; for commissioning and carrying out (via Forest Research) forest and woodland research; and for managing the national and regional consultations that generate forest and woodland strategies within each country. The Commission is currently a department within Defra in England, and within the Rural Affairs Department in Wales; and is currently finalising a Service Delivery Agreement with HM Treasury based on a range of performance targets for new delivery over the period to 2020.

The Forestry Commission, in both England and Wales, is able to implement policy and deliver strategy in a range of ways. The most important of these is the managing the state owned forests and woodlands; assessing, awarding and monitoring planting, restocking and management grants to private sector forest owners; approving the felling of trees and timber; administering Environmental Impact Assessment Regulations as they relate to forestry; undertaking and promoting the results of forestry research; participating in development partnerships with other organisations; and providing advice and guidance to government and to public sector agencies.

The Forestry Commission has had a long-standing research interest in the role of trees in the water cycle, predominantly from the silvicultural, harvesting and acidification perspective; and has been involved in initiatives to re-create or strengthen riparian forests. To date, its role in flood management via forestry has been relatively limited. In the Forestry Foundation Strategy for Yorkshire and the Humber (Firn Crichton Roberts Ltd and John Clegg Consulting Ltd, 2002), the Commission, Yorkshire Forward and their strategy partners accepted a strategic recommendation to address the growing River Ouse flood problem through increased planting of appropriate forests and woodlands throughout the river's catchment area (refer to Section 5.6.2).

Defra and its Agencies
Defra has a number of policy, funding and research roles which have a direct impact on forestry in England. These include:

- Strengthening rural sectors and communities;
- Promoting sustainable development and targets for these;
- Caring for the natural heritage and environment; and
- Promoting biodiversity and protecting important natural habitats and wildlife sites; and
- Ensuring that the countryside is attractive and enjoyable for everyone.

It pursues these roles and responsibilities in relation to forestry and woodlands via a range of policy and strategy implementation mechanisms including the England Rural Development Programme (ERDP), which is partially funded by the EU; provision of grants for the conversion of agricultural land to woodlands via the Farm Woodland Premium Scheme (FWPS); providing further grant support and regulation via its own Department through the Forestry Commission, and its three core operational agencies (the Environment Agency, English Nature, and the Countryside Agency).

As a result of the Haskins' Review, it is probable that there will be a major re-organisation and re-structuring of Defra and its constituent agencies to ensure reduced duplication and a closer integration with the policies and strategies of the English Regional Development Agencies. Such a development would perhaps make it easier to integrate forestry and woodland policy, investment and management into catchment management strategies and plans.

This is likely to be encouraged by the results of recent research (Calder, 1999) which suggest that tree cover in upland areas reduce water flow into rivers by 30% compared to grass or moorland grasses, and 18-20% where the alternative land cover is bracken (Willis, 2002). These impacts are currently viewed as negative influences by forestry, where assuming a direct one-to-one trade off between forestry and water availability, the external annual costs of forestry on water supply are estimated to be £52.5 million for England and £35.4 million for Wales. It is suggested that such costs may be significantly smaller than the as yet unquantified benefits that forests and woodlands may have on reducing flood risk and extent. This is an area where further research should be commissioned in parallel with, and to directly support, future integration of agriculture, forestry and environmental policies to improve flood management in England and Wales.

Welsh Assembly Government
The Welsh Assembly Government (WAG) is responsible for determining forest policy in Wales and for its subsequent delivery.

Regional Development Agencies
The recent establishment of Regional Development Agencies (RDAs) in England, alongside the much longer-lived Welsh Development Agency, is introducing a further group of institutional mechanisms capable of encouraging the use of forestry and woodlands to address regional economic, environmental and social development goals. The investment partnerships of the RDAs with their local public and voluntary sector stakeholders often involve new or refurbished property, leisure and infrastructure developments alongside river or open water features. In this task, the RDAs work

closely with the new integrated government offices in each region, and are seen as the prime delivery mechanism for regional policies. In addition, the devolution of forestry policy to the English regions, and the current preparation and launch of Forestry Foundation Strategies for each region, will enable the RDAs in partnership with the Forestry Commission to explore new ways to address flood and water supply management.