Spatial heterogeneity in landscape multi-functionality; the challenges for forestry policy in Scotland.

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ABSTRACT

Since the early 1990s, the idea of multi-functionality has become firmly embedded in the rhetoric of forestry policy. This has raised a number of challenges for policy makers, which are especially critical in the development of Environmental Service Payments (ESP) or Agri-Environmental Schemes (AES) whereby private landowners are paid to provide specific environmental services or non-market benefits through woodland planting or improved management of existing woodlands. Much research has been devoted to the development of best practice guidelines for site-level management with regards to different woodland functions. However, there have been far fewer research efforts to develop guidance for multi-functional woodland management at the landscape level. This paper draws attention to the potential spatial trade-offs of the various functions associated with woodlands. The spatial modelling of three different forest functions in a case study area in the North East of Scotland shows that, although there are broad areas where all three functions have a high potential (win-win-win locations), most of the region is covered by areas where the three functions do not coincide, including large areas where all three functions have low scores. This has important consequences for the spatial planning of forestry policy, as it calls for different spatial targeting strategies for forestry schemes aiming to deliver different types of woodland functions. In the light of these findings, we provide a critical examination of the nature and development of the current spatial planning tool for forestry in Scotland, the Indicative Forestry Strategy (IFS).

1 INTRODUCTION

In the post-Rio (1992) era, the concept of multifunctional land use has become a standard ingredient in forestry policies. This is in part related to a number of international agreements reached at the time, such as the Convention on Climate Change, the Convention on Biodiversity and the Statement of Principles for the Sustainable Management of Forests. However there may be other drivers for the popularity of the concept. Most developed countries already have a growing forest cover (the 'forest transition phase', see Mather and Needle, 1999) as a result of abandonment and/or the deliberate afforestation of marginal agricultural land, which has gone hand-in-hand with intensified and subsidized agricultural production on the best quality land. These subsidies are now under increased scrutiny. Reduction or abolition of production-related subsidies is deemed necessary to counter the financial costs, the overproduction, the environmental impacts and the unfair competition in a period of increased international trade liberalisation and EU expansion. Encouragement of the afforestation of farmland can be seen as a measure to reduce agricultural overproduction and simultaneously implement forestry policy in accordance with international agreements. In various EU countries, including the UK, afforestation of agricultural land is now encouraged and financially supported as an agri-environmental scheme (AES) within the framework of the Common Agricultural Policy.

The subsidised planting of new 'multi-purpose' woodlands is not exclusive to Europe or to the developed countries. State-led (re)afforestation

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projects have taken place in many countries, often creating 'monoculture' plantations of exotic commercial timber species. A more recent trend has emerged to pay private landowners to plant trees in order to provide environmental services to society. This type of economic instrument is known as Environmental Services Payment (ESP) and it is championed, for example, by the World Bank (Pagiola et al., 2004). The development of an effective forestry policy wherein AES or ESP play an important role can throw up a number of challenges. There is amongst others a need to (a) decide on the environmental services which afforestation should deliver, (b) understand how each service can be delivered –i.e. what species, where planted, how managed-, (c) understand the synergies or trade-offs between different services and use this knowledge when prioritising between these services, (d) understand the wider impacts of the various afforestation options, (e) devise an incentive scheme which is effective, efficient, affordable, manageable and, ideally, also equitable.

This paper focuses on one aspect of forestry policy which impacts on all of the above questions, namely the decision of where to target AES or ESP incentives (to plant new woodlands or apply a specific management regime to existing woodlands) at the landscape or regional scale.

The need to adjust the design of woodland at the site level to serve a specific benefit has long been recognised. For example in the UK, site level design regulations and best practice recommendations include the UK forestry standard, forest design planning and forest landscape design guidelines. But to what extent has the importance of the location of woodlands in the wider landscape been recognized in the design of UK forestry policy?

There are a number of established environmental and conservation policies and schemes that apply to specific geographical areas or exclude locations with certain characteristics. However the appropriateness of those policy interventions can be questioned when the delineation of the target areas (if at all transparent) may have been shaped by existing administrative boundaries rather than being based on an analysis of the spatial distribution of the various environmental benefits, functions or services. Furthermore, these existing target areas are usually treated as internally homogeneous with regards to potential benefit provision. Criticism of such ineffectively delineated designation for conservation (Environmentally Sensitive Areas; Areas of Outstanding Natural Beauty) of pollution prevention (Nitrate Sensitive Areas) in the UK alone can be found in Hutchinson et al. (1995), Wilson (1997), Thompson et al. (1999) and Osborn and Cook (1997).

Also schemes or policies that do not apply to explicitly defined geographical areas will, in all likelihood, result in uneven spatial patterns of uptake. Many relevant elements in current policies are heterogeneously distributed in space. For example AES payments may be designed to target farm type or type of land-use. However farm types, spatial patterns of ownership or agricultural land values are not homogenously distributed and, as a result, the uptake of these policies will be spatially heterogeneous at the landscape or regional scale. This might result in a spatial pattern of uptake which, at the landscape scale, might be neutral or even counterproductive to the aims of existing policies. For example the planting of coniferous woodlands in some sensitive upland areas may increase acidification, while new woodlands on wet peaty soils may lower the water table and result in a net reduction of carbon storage. Both examples may also result in a net reduction of biodiversity. Finally, woodlands planted in locations which people cannot access or see from accessible places, may only yield recreational and landscape benefits to the farmer.

The systematic inclusion of benefit-explicit spatial targeting in forestry policies can be expected to raise the flow of benefits from the woodlands created or affected by such policies (van der Horst, 2006a). The design of such policies depends on analytical methods to quantify the amount of expected or estimated public benefits as a function of spatial variables. A number of academic publications have presented such methods (see Table 1) the resulting maps invariably show that these forestry benefits are highly spatially heterogeneous at the landscape or regional scale.

Table 1: Existing methods to map different woodland functions or benefits

Type of forestry benefit	Mapping methods developed by
Timber yield	Macmillan and Chalmers, 1992; Allison et al., 1994; Bateman and Lovett, 1998
Forest recreation	Brainard et al., 2001; Hill and Courtney, 2006
Carbon sequestration	Bateman and Lovett, 2000
Visual/landscape amenity	Hunziker and Kienast, 1999; van der Horst, 2006b
Biodiversity	van der Horst and Gimona, 2005

This paper aims to use some of these analytical methods (a) to explore the extent to which forestry can actually be multi-functional at any one location in the landscape and (b) to evaluate the spatial strategies in Scottish forestry policy since the early 1990s.

The paper is structured as follows. In section two of this paper we will examine the spatial co-distribution of three key woodland benefits (biodiversity, visual amenity and woodland recreation) within a regional setting of North East Scotland, to evaluate to what extent woodland multi-functionality actually exists at any given location in the landscape. In section three we will examine the spatial nature of the evolving forestry policy framework in Scotland, focusing especially on the design of Indicative Forestry Strategies (IFS) as these are summarized and communicated through maps of where woodland plantings would or would not be preferred. In section four we will compare the findings of section two and three and discuss to what extent existing forestry policy is in line or at odds with the findings of recent spatial modeling approaches to landscape multi-functionality.

2 SPATIAL SYNERGIES BETWEEN THREE POTENTIAL BENEFITS OF FARM WOODLAND PLANTINGS; A CASE STUDY IN NORTH EAST SCOTLAND

Methodology

The three woodland benefit maps used in this analysis were the results of earlier published work which will briefly be described in the sections below. Figure 1 displays these three benefit maps, with the different grey tones indicating the first, second, and third quartile of the distribution of scores. A k-means cluster analysis was carried out in order to determine the nature of the spatial distribution of the three benefit maps. The clusters resulting from the analysis were mapped with different grey tones to display a combined classification of the three benefit values.

Potential biodiversity benefit map

In van der Horst and Gimona (2005), evaluation of the potential biodiversity benefits of farm woodlands was based on a species-centred approach which used spatially-explicit habitat suitability models for 16 species deemed to be priority species in the Local Biodiversity Action Plan. For each species a preference map was generated indicating for each grid cell on the map how afforestation of that grid cell would affect the species (positively, negatively or no effect). As some species are more rare than others, or more likely to be affected by afforestation than others, a weighting system was developed to represent the relative priority of each species. As a last step, the preference maps for individual species where weighted by the species' priority and then aggregated to an overall biodiversity benefit score.

Potential visual amenity benefit map

In van der Horst (2006b), the aggregate visual amenity score (AVAS) of each grid cell is calculated on the basis of four key variables, namely the spatial distribution of the (viewing) population, the general preference of the public for the amount of woodland they like to see in the

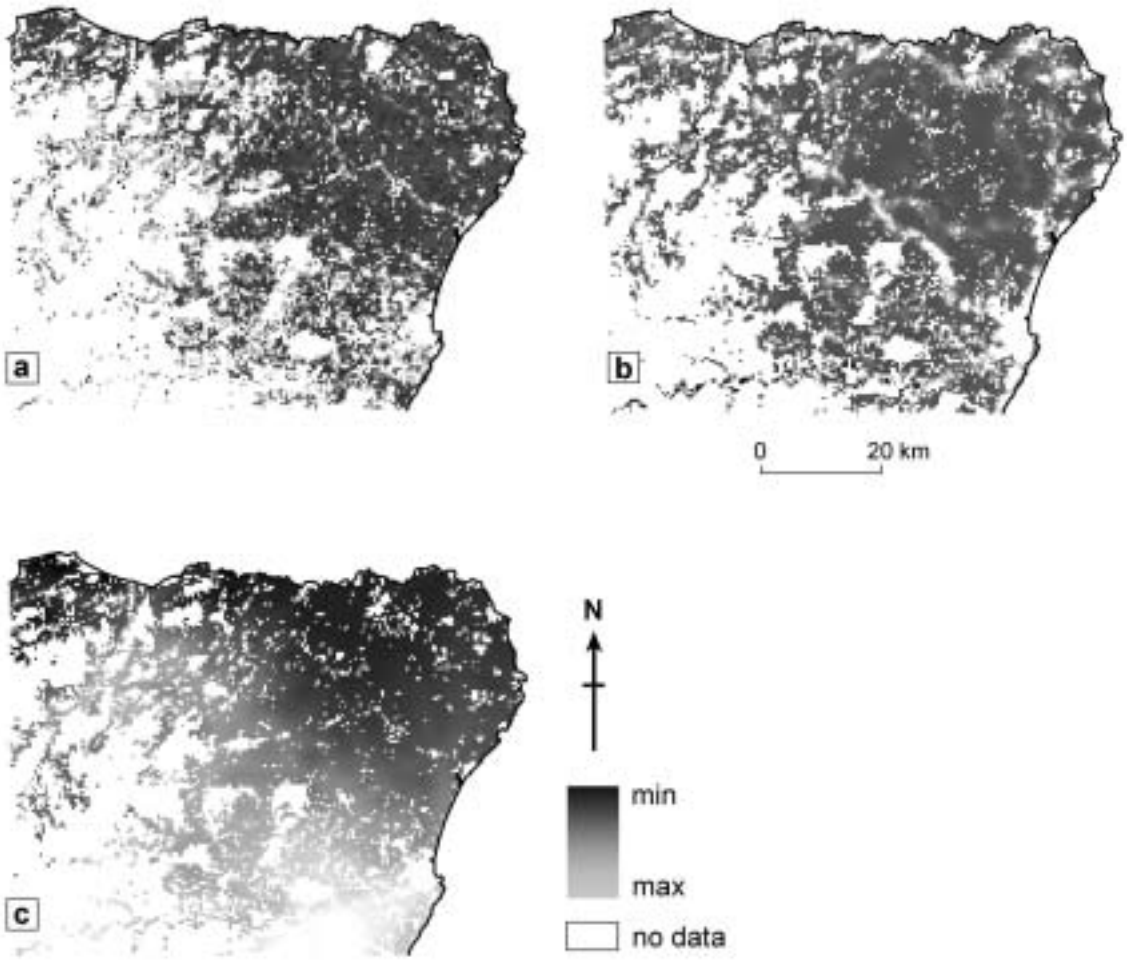

Figure 1: Benefit maps of the case study area (North East Scotland)
a) biodiversity benefits ; b) visual amenity benefits; c) woodland recreation benefits

landscape, the amount of woodland already visible in the local landscape and the actual visibility of grid cells in the landscape from (public) points of observation.

Potential woodland recreation map

This map was created on the basis of the analysis by Hill and Courtney (2006). This methodology estimates the expected number of visitors at any grid cell as an inverse function of distance to where people live, weighted by the number of people living there (i.e. a distance decay function of weighted population centres). This method calculates distance on the basis of the existing road network and also takes account of substitute sites of woodland recreation, i.e. people living in an area with little woodland cover are assumed to be willing to travel relatively longer distances for the purpose of woodland recreation.

Results of the cluster analysis

The map in Figure 2 shows that there are some "win-win-win" areas in the landscape which offer benefits from the point of view of each of the three criteria used in this study. Most of these are located in the western part, and are along river valleys and roads which follow them. These areas should be targeted for farm woodland plantings because they are truly multi-functional. Conversely, there are also 'lose-lose-lose' areas, located mostly in the North-Eastern part of the study area, where afforestation would not be beneficial for any of the three criteria. These are areas where planting would result in isolated woodlots and cause loss of habitat for open ground species. Also, they are relatively less well connected and reachable by visitors and have limited visual amenity value because the gently undulating landscape with a low road network density offers few opportunities to create

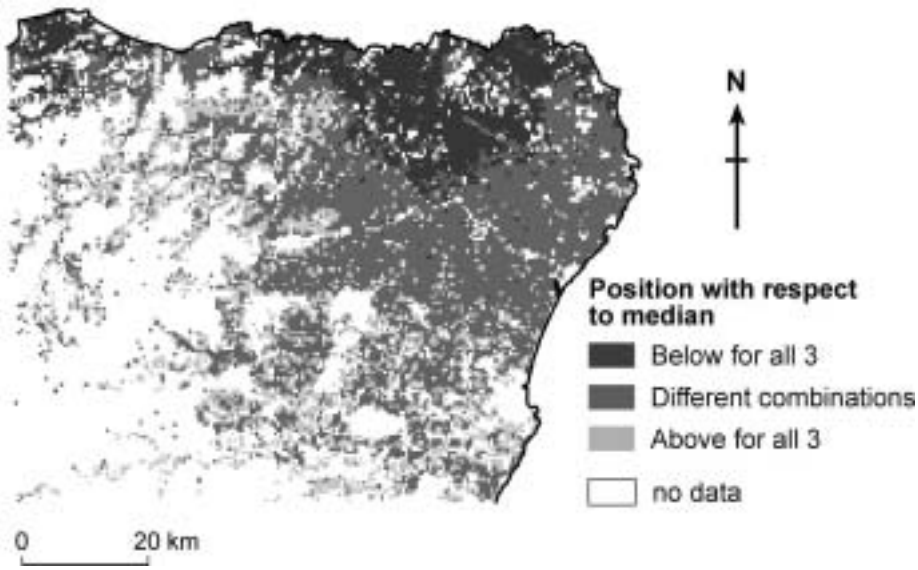

Figure 2: A classification of multifunctionality resulting from a cluster analysis of the three benefits. 'Above for all 3' are win-win-win areas where the planting of multifunctional woodlands will provide the highest overall benefits.

visually attractive woodlands for a large number of people.

The results of this study demonstrate that the level of multi-functionality cannot be assumed to be constant across the landscape. Within the case study area there is a strong regional trend in the spatial heterogeneity of these three functions, with benefit criteria correlated over some fairly large areas. This obviously has important implications for the spatial targeting of (subsidies or efforts to stimulate) woodland plantings. Roughly 22% of the study area would provide benefits according to all the criteria used in this study. Plantings in such multi-functional 'hotspots' is likely to provide the highest overall value for money (assuming of course that agricultural opportunity costs are not much higher in the same area). These findings open up a possibility to evaluate the spatial targeting strategies within the existing forestry policy framework in Scotland.

3 EXISTING SPATIAL TARGETING STRATEGIES IN SCOTTISH FORESTRY POLICY

Location specific top-up funds

Forestry policy initiatives in Scotland since the late 1980s have in the main focused on stimulating further afforestation by offering financial incentives to landowners on a voluntary basis. Providing an extensive overview of forestry policy in Scotland lies outside the scope of this paper. Instead we will highlight a number of initiatives over the last 15 years[1] that are spatially targeted. The Woodland Grants Scheme and its successor the Scottish Forestry Grants Scheme (SFGS[2]) provide a one-off payment to cover some of the costs of planting, while there are a number of top-up funds available in specific parts of the country, including the following four.

The Farm Woodland Scheme (introduced 1988), its successors the Farm Woodland Premium scheme (FWPS, introduced in 1992) and the Farmland Premium (SFGS/FP, introduced in 2003) aim to encourage the creation of new woodlands on land that was previously used for farming. Through this scheme, more than 33000 ha of new Scottish woodland have been created over the course of its first decade alone (SO, 1999), making farm woodlands the most important type of woodland expansion in Scotland.

An element of the spatial distribution of recreation need is reflected in the Community Woodland Supplement (CWS). The CWS was made available for proposed woodlands that had to be accessible to the public and had to be created within 5 miles from the edge of town or city in an area with few other woodlands. It is interesting to note that these are the same key variables of analytical woodland recreation models (Brainard et al., 2001; Hill and Courtney, 2006) however the exact meaning of 'few' is not specified, while the

justification of a 5 mile cut-off distance is not provided.

Within the original range of the original Caledonian forest, (the natural boreal woodland that covered much of the Scottish Highlands at the end of the last ice age currently reduced to about 2% of its original size), land owners are offered the Native Woodland Supplement. This supplement is available for the creation of new woodlands through planting or natural colonisation, in such ways as to emulate the natural woodland system which has disappeared.

Challenge Funds are top-up payments which are allocated on the basis of competitive bidding within specific geographical areas. Land owners have to tender for these funds, and the plans they submit are judged by a panel of experts on the basis of value for money. Challenge Funds apply to 'priority' areas which have been identified on the basis of various environmental, economic and social reasons (Forestry Commission, 2000b). The Cairngorms Challenge Fund and the Argyll and Bute Challenge Fund are for example focused on improving the biodiversity of existing woodlands and extending the cover of native woodlands. The Central Scotland Challenge Fund (between Glasgow and Edinburgh) and the Grampian Forest Challenge Fund (north and east of the main road [A96] between Aberdeen and Keith) are more focused on creating new productive woodlands which also provide recreation and conservation benefits, as well as helping to 'diversify rural land uses' within agricultural areas where woodland cover is relatively scarce and the recreational potential relatively high (Forestry Commission, 1999b).

Indicative Forestry Strategies; 'first round'

The above mentioned initiatives concern different aims and relate to explicitly delineated geographical areas. An integrated forestry policy requires that such initiatives be embedded in a more comprehensive and systematic approach to regional spatial planning. In 1989 the Scottish Office launched an initiative to promote the development of Indicative Forestry Strategies (IFS) at the regional level. The development of the IFS was a response to widespread concerns about the environmental damage caused by private sector plantings in the 1980s, notably on rare peat bogs in the Flow Country in the very north of Scotland. These strategies have subsequently been developed in the early 1990s by most of Scotland's regional councils along broadly similar lines (SDD, 1990). All regional IFSs consist of a report containing a number of regional maps with background information relevant for forestry, including existing woodlands, agriculture, nature conservation, archaeology, water catchments, recreation and tourism. This information had to be summarised in a schematic strategy map with five standard categories; existing woodlands, land physically unsuitable for planting (e.g. high mountains, build up areas), preferred, potential and sensitive areas. Preferred areas (green) have been defined as areas which have no major constraints to forestry, potential areas (yellow) have one major constraint which would have to be resolved, sensitive areas (brown) have more than one major constraint (SDD, 1990). The strategy maps were created through a 'sieve-mapping' process; overlaying the various background maps which represented constraints to further afforestation, and drawing boundaries around areas with the same number of constraints.

The functions of the IFS was (a) to provide a framework for responses by planning authorities when consulted by the Forestry Commission on planting grant applications; and (b) to provide an indication to landowners and other forestry investors of the opportunities for further forestry development, of the degree of sensitivity of areas of land to new woodland planting and of the extent of consultation likely to be required (SDD, 1990).

The IFS were intended to 'represent a broad assessment, at a regional level and on an outline basis, of the opportunities for new planting taking account of environmental and other factors' (SDD, 1990). They were intended to be based on extensive surveys and the identification of many conflicting interests, both conceptually and spatially. After 60 years of timber-oriented forestry policy, the IFS had an important role in taking environmental and other factors into account. Although timber production remained the main

objective, the importance of multi-purpose woodland management was acknowledged. In addition to the existing forestry policy at the national level, local authorities were now allowed to develop their own vision of forestry, which could be incorporated into their structure plans. The tone of the circular was not merely restrictive, i.e. focused on constraints. Phrasing such as "preferred" areas where "opportunities" for planting should be "actively promoted" (SO, 1990; p 9), hinted at the development of a more proactive or positive approach to spatial planning of new plantings. However this positive rhetoric stood in contrast to the method used to identify the three categories, which was based around 'sieve mapping' of constraints.

Except for the regional councils for Lothian, Shetland, Orkney and the Western Isles, who did not expect a significant amount of tree planting, all Scottish regions prepared a regional IFS. In regions where afforestation was a more controversial issue (Strathclyde, Highlands), spatial planting guidelines had been developed before the 1990 IFS circular was issued. Strathclyde adopted their IFS as early as 1989, Highlands adopted their (revised) IFS only in 1994. The national guidance notwithstanding, some regional IFSs differed widely. The 1990 IFS of the Dumfries & Galloway Region for example, is a simple grid map of 1 km squares. By comparison, the 1994 IFS of the Highland Region stands out for its analytical and detailed approach, taking additional issues into account, such as hunting, minerals and transport. It is the only regional IFS which produced a map of the preferred/potential/sensitive categories for all land suitable for forestry, thus allowing the evaluation of the locations of existing woodlands.

Indicative Forestry Strategies; evaluation of the 'first round'

In response to changes in government policy (inclusion of the sustainability agenda) and increased sensitivity of environmental issues in relation to planting, an 'evaluation' of the regional IFSs was commissioned in 1995 (Scottish Office, 1997). The evaluation was focused on the way in which the regional IFSs are used, if there was still a need for them and if the guidance given in the 1990 circular needed to be changed. After interviews with regional IFS authors, Forest Authority, consultees and applicants for the Woodland Grant Scheme (WGS), the study concluded that there is a continuing need to provide a broad assessment of the opportunities for, and constraints on, new planting to reflect changes in Government policy. It found that there was some confusion about the role that the IFS can play in WGS consultation, especially in relation to the indicative nature of IFS and the geographical scale at which it can realistically operate. It observed a general desire to adapt and develop the IFS to meet current needs with a developing consensus in favour of linking instruments at national, regional and local levels, including incentives to target investment in specific types of planting into defined areas. Finally it recognised the need for monitoring of new planting within IFS categories in order to evaluate whether IFS are meeting their aims.

The study also concluded that the IFS has four functions (SO, 1997); To identify target areas for types of planting which reflect environmental sensitivities and the benefits that forestry could provide at a regional scale; To provide a broad framework for consultation on WGS applications, reducing the extent of consultation required, particularly on smaller schemes in less sensitive areas; To build trust by revising and developing the regional IFS as a collaborative exercise between the parties interested in new planting; And to provide a framework for the FA to consider the targeting of grants for new planting.

It could be argued that the Scottish Office 1997 report is more a consultation than an evaluation. It seems that the 'evaluation' element in the report is mainly presented by the critical comments of some of the local planning authorities, who had to design and use the IFS according to centralised guidelines. However these reported comments are not quite as blunt as the statement in the Highland Region IFS that "the labels we are required to use by the Scottish Office for the three basic categories in the IFS are misleading" (Highland Regional Council, 1993, p 81). In their final IFS map they use an additional category, that of "potential (for further study)". Grampian Regional Council must have also been dissatisfied with these categories since

they opted for using the category "prospective" rather than potential (Grampian Regional Council, 1992).

The first stated aim of the 1997 Scottish Office evaluation is to assess whether the regional IFS have "eased the pressure for new planting in sensitive areas" (SO, 1997; page 3). However, the report only discusses the incomplete data available from two regions. Information from Strathclyde suggested strong annual fluctuations in the spatial distribution of plantings across the IFS categories with an increasing bias towards planting in preferred areas. In Tayside about 50-80% of all the plantings in any one period took place in sensitive areas but most of this planting concerned native species, "probably native pinewood schemes" (SO, 1997; page 17).

The 1997 Scottish Office evaluation notes that most other regions have not monitored the location of plantings according to IFS categories, and for this reason does not attempt a systematic assessment of the effect of the regional IFS on location of new plantings. This seems to suggest that the regional authorities were insufficiently convinced of either the need to control planting or of their IFS' suitability for doing so. It is also not clear why no effort was made to address this important hiatus as part of the 1997 'evaluation', especially as it is not a difficult exercise. The Forestry Commission is obliged to provide the local authorities with detailed information on the nature and location of new forestry planting (SDD, 1990). The Forestry Commission registers the x and y coordinates of the centroids of those fields which have been planted (this is in line with the EU's Integrated Administration and Control Scheme [IACS], which demands that farmers provide land use data at the field level for the administration, monitoring and control of agricultural subsidy payments). Overlaying an IFS map with the locations of plantings and counting the number of new planting per IFS category is a simple operation. Doing so for a random sample of 55 woodlands planted under Farm Woodland Premium Scheme in the Grampian region (i.e. North East Scotland) shows that 21 woodlands were planted in preferred areas, 20 woodlands were planted in potential areas and 14 woodlands were planted in sensitive areas (van der Horst, 2002). In terms of acreage, 29% is on preferred land, 29% on potential land and 42% on sensitive land (ibid.) which shows that the Grampian IFS has done little to target plantings away from sensitive areas and towards preferred areas. An alternative method of evaluation is demonstrated by Stuart-Murray et al. (1999). They have analysed satellite imagery of the Borders Region and concluded that in the period 1988-1995 new plantings have predominantly taken place on sensitive land, mostly in the form of reafforestation.

With a systematic assessment of the locations of new plantings missing in the 1997 Scottish Office evaluation (despite obvious feasibility), and the above four regional case studies suggesting mixed results at best, it is surprising to find that "The Government believe that IFS have played an important part in ensuring that the right types of trees are planted in the right places" (SDD, 1999; page 8). Clearly the evidence at hand indicates that the first round IFS, in these regions at least, has been a rather ineffective targeting tool for new woodland plantings.

Indicative Forestry Strategies; 'second round'

Following the evaluation of the first round IFS, a revised IFS circular (SDD, 1999) was published by the Scottish Office, urging the local authorities[3] to change and update the existing regional IFSs. The 1999 IFS circular differs from the 1990 circular in a number of ways. It puts a greater stress on the positive role which forestry can have, with the methodology supposedly shifting from sieve-mapping of constraints towards mapping of opportunities for improving the environment and economy of many areas. The new circular acknowledges the need to distinguish between different types of planting preferred in different areas to provide different benefits. It also suggests that the Forestry Commission would like to use the regional IFSs as a basis for spatial targeting of financial planting incentives. Other important differences with the 1990 SDD circular it supersedes are:

- A greater stress on the multi-benefit nature of forestry (note the changed terminology from multi-purpose to multi-benefit), with timber no

longer being the dominant objective.

- A greater stress on the positive role which forestry can have, the exercise shifting from sieve-mapping of constraints towards mapping of opportunities for improving the environment and economy of many areas.
- An acknowledgment of the need to distinguish between different types of planting preferred in different areas to provide different benefits.
- The inclusion of existing forests and the possible need to restructure these.
- A call for improved monitoring and maintenance of background information as a source of reference for various forestry decisions, thus allowing a review of the effectiveness of the IFS.
- A call on the planning authority to develop a long-term vision ("next ten years or so") on the range of economic, social and environmental benefits which forestry could deliver.
- More stress on partnership and consensus building, as well as local democratic accountability.
- More stress on an integrated approach, linking in with national, European and international policies and agreements.

The new circular refers to more issues, some of which may have been informed by individual first round IFS, such as existing woodlands, transport and infrastructure (Highlands) and landscape character (Tayside). The issue of the spatial scale of the analysis has only been partially resolved. According to the new circular, the level of coverage and degree of sophistication in approach should be higher for rural areas (where forestry is a more significant feature) than for more urbanised areas. It could be argued, however, that woodlands in more populated areas can provide a much higher (total) benefit in terms of recreation and landscape enhancement than remote rural woodlands can. As afforestation is publicly funded, it seems fair to give high priority to those areas which will benefit a larger number of tax payers[4]. And since settlements are often surrounded by relatively densely populated small-scale landscapes, these would require a more spatially detailed approach.

The new circular also lacks conviction in addressing the most pertinent point of previous criticism (MacMillan, 1990; Stuart-Murray, 1994) in that the old preferred/potential/sensitive categories have been retained, albeit with some changes in the definitions. Moreover, while the 1990 circular was detailed in its description of how to approach the sieve mapping exercise, the new circular remains remarkably vague about how to arrive at the final strategy map.

4 COMPARING THE CONSULTATIVE IFS APPROACH WITH THE ANALYTICAL MULTI-BENEFIT MAPPING APPROACH; A DISCUSSION

Both IFS circulars, and many of the resulting regional IFSs can be criticised. Not only is there evidence to suggest the IFS have not effectively served their primary function, but more importantly, the methods by which the IFSs have been designed have not been critically assessed during the official evaluation, despite evidence that there is much room for improvement. Considering the criticism levelled at and the lessons learned from the first circular and regional IFSs, the new circular seems less than impressive. It retains the vague categories of sensitive/potential/preferred as opposed to being more explicit about benefits like forestry planning in some other countries. For example in Poland forests are categorised according to their main and sub-functions. So-called protection forests are subdivided in forest preserves, soil protection forests, water protection forests, landscape forests, recreational forests etc. (Strange et al., 1999). Also in Austria, the Forest Development Plan classifies forests into their main functions, including protective functions (against rock-fall, avalanches, floods and erosion), water supply, recreation etc. (Griess, 1999).

Unlike the 1990 circular, the 1999 circular does not refer to the 'degrees' of conservation or scenic values, despite the fact that methods and data are now much more widely available to model, quantify and display the spatial distribution of the potential benefits of woodlands (see Table 1). The 1999 circular states that the first round IFSs have to be changed and improved upon, but it does not offer much of a vision on how such changes or improvements can best be achieved. One such vision is presented in this paper. It would be

relatively easy to create benefit maps which provide a synthesis of a range of potential value maps, by 'weighting' between competing benefits. This could be achieved through a process of public and stakeholder consultation. Such benefit-specific IFS maps would thus be based on 'state of the art' analytical models, be more transparent and accountable, and more directly applicable for the spatial targeting of benefit-explicit incentive schemes (along the lines of the existing locational top-up funds).

The examples of quantified potential benefit maps provided in Table 1 currently differ in terms of modelling complexity, spatial detail, underlying assumptions etc. Whilst there is much scope for further improvement, the indicative nature of the IFS suggests that these existing methods, can already play a more important role in forestry planning. It could be argued that it is more effective and efficient to have a uniform, Scotland-wide approach to the mapping of a number of prescriptive factors relevant to the location of forestry, such as biodiversity or carbon sequestration. This would reduce the burden of method development on the new local authorities, increase transparency, guarantee a minimum level of quality and comparability of regional IFSs and probably speed up the development of the second round regional IFSs. The disadvantages of relying on such top-down models could be much reduced by including local knowledge and by applying different regional or even local weighting of the different benefits in accordance with locally important issues raised by stakeholders. These are concepts which are increasingly being addressed through the development of public participation GIS (Jankowski et al., 1997; Bojorquez-Tapia et al., 2001).

The sustainability agenda is seen as necessitating a problematic change from the more traditional restrictive planning system towards more 'positive' planning (e.g. Selman, 1997; Rydin, 1998) and this is reflected in the uneven developmental process of the IFS. The official circulars are 'middle of the road' documents at best, containing both restrictive and progressive elements. The regional IFSs on the other hand ranged from the most basic interpretation of the circular to the Highland approach which, in 1994, was in some respects more advanced than the 1999 circular. There is thus tension between different regional IFSs, and between regional IFSs and the national guidance, which is in turn moving towards further integration with the national rural development agenda. Some of this tension may beneficially result in more creative approaches and in the exchange of ideas and knowledge. The use of more 'purely analytical' models for mapping woodland multi-functionality, such as the one demonstrated in this paper, can add to this creative tension by challenging the scientific validity of the various aspects of the regional IFSs which were developed in a much more 'messy' iterative process involving stakeholder consultation, expert input and sometimes also the (non-transparent) use of various analytical approaches.

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Notes:

1 Some of these schemes have changed little over time, others have been amalgamated or discontinued

2 This scheme has just been stopped because funding ran out due to unprecedented numbers of new applications. There will be a continuation of sorts under the new Rural Development Regulations which come into force in 2007.

3 by that time some regions had been split up in smaller local authorities

4 this obviously applies only to benefits which depend on accessibility (‘use values’) such as recreation and landscape, not to other values such as biodiversity or carbon sequestration (see van der Horst, 2006a).