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Encroachment upon protected areas within the Greater Dublin Area under two simulated futures

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Introduction

The Urban Environment Project (UEP) is a multi-disciplinary, inter-institutional research project whose goal is to develop a Spatial Decision Support System (SDSS) for the Greater Dublin Area (GDA) (figure 1) so that policy makers can explore the environmental effects of policy alternatives before implementation and make evidence based decisions. The questions and problems posed by the specialist teams (Air Quality, Biodiversity, Climate Change, Transport and Urban Sprawl) are based in an environmental framework, and the land-use model MOLAND is the engine room for producing possible outcomes and scenarios to aid visualisation and direct comparison of a selection of infrastructure developments at both regional and local scales.

The need for a SDSS is particularly relevant for the GDA, which has undergone massive and rapid development in the past decade (Williams and Shiels 2002, Williams et al. 2007). This development has had several negative effects, e.g. urban sprawl and habitat destruction (European Environment Agency 2006). To attempt to steer this development towards sustainability several government documents were produced, beginning with the Strategic Planning Guidelines for the Greater Dublin Area (Dublin Regional Authority and Mid-East Regional Authority 1999), followed by Regional Planning Guidelines for each of the seven Regions in the state in 2004 (Dublin Regional Authority and Mid-East Regional Authority 2004). Section 26(1) of the Planning and Development Act 2000 provides that RPGs be reviewed not later than six years after the making of the guidelines i.e. by 2010 in the GDA’s case (Government of Ireland 2000). As part of this process we are currently collaborating with the Dublin & Mid-East Regional Planning Authority’s SEA process, whereby we are constructing a spectrum of possibly future development scenarios which take into varying levels of economic growth/decline; population fluctuations; a range of green infrastructure options; transport modal shift, on-time versus delayed transport network upgrades and all combinations of the above. In this paper I will briefly describe two of these future development scenarios (continued trends vs. consolidation and creation of green belts), discuss one indicator (in this case encroachment of development upon legally protected areas) and summarise the differences between the simulations.

Methods

The MOLAND model

Rather than give full details of the MOLAND model, which can be found elsewhere (Barredo et al. 2003) we will summarise the model’s requirements and outputs. MOLAND comprises two sub-models working at different scales. At the macro (regional) scale, the model takes as inputs the population and the economic activity in a region. This population and activity is then split between the sub-regions encapsulated in the model area. In this application, the sub-regions are the administrative counties within the region. At the micro scale (local) the detailed allocation of economic activities and people is modelled by means of a Cellular Automata based on land use model (Engelen et al. 2004). To that effect, the area modelled is represented as a mosaic of grid cells of 4ha each (200m on the side). This model is driven by the demand for land per region generated at the regional level. Four elements determine whether each 4ha cell is taken in by a particular land use function or not:

- the accessibility for each land use function calculated relative to the transport network;
- physical suitability determining the physical, ecological and environmental appropriateness of cell to support a land use function and associated activity;
• zoning status or institutional suitability (e.g. legal constraints);

• Neighbourhood rules: the model assesses the quality of its neighbourhood; a circular area with a radius of 8 cells. For each land use function, a set of rules determines the degree to which it is attracted to, or repelled by, the other functions present in the neighbourhood.

Based on the above transition potentials are calculated for each cell by the model for every simulation step, typically 1 year in a land use change model (White and Engelen 2000). Over time and until regional demands are satisfied, cells will change to the land use function for which they have the highest potential.

Calibration is achieved by running simulations over a known historical period. The simulations are initiated using the historical dataset in order to test the simulation results using the reference dataset. Subsequently the simulations are validated by running the model forward and checking the consistency of the resulting map. The future simulation of land-use can then be performed using the parameters of the already calibrated model assuming, however, that the calibrated factors will remain relatively stable during the studied period. Detailed description of the calibration technique and used datasets for GDA is presented in a separate paper (Shahumyan et al. 2009).
Divergent policies are generally explored by manipulating the zoning and suitability layers, e.g. ecologically important areas can be zoned to prohibit development during a simulation run, areas proximate to public transport/urban centres can be classed as “more suitable” for development than distant areas or vice versa.

The Scenarios

Scenario 1 explores a continuation of current trends whereby a significant divergence between spatial planning policy and practice has been noted (MacLaran and Williams 2003, Scott et al. 2006), which indicates the capacity of spatial planning policies to steer the location of development at the city-regional scale may be limited.

In Scenario 2 a policy of consolidation and “strong” green belts is imposed to steer future development away from the dispersed settlement patterns that have characterised GDA development recently. Green Belts were constructed using Arcmap GIS software and used to create restricted zoning maps for the MOLAND model. Within the area covered by the Green Belts development was prohibited from occurring. Consolidation was promoted using the suitability layer. Five kilometre buffers were created around key towns listed in the most recent Regional Planning Guidelines (Dublin Regional Authority and Mid-East Regional Authority 2004). Land inside of this buffer was classed as more suitable for development than land outside the buffer. It should be noted that development can still occur outside the buffer.

Measures of encroachment upon protected areas

To identify which sites would be threatened and quantify the impact of forecasted development a 1km buffer was created around the protected areas merged using GIS. To allow a per county analysis this polygon was intersected with a County shape file to produce five polygons, representing the protected areas of each county. Cell counts within these buffers were found using a customised tool developed by UEP. Cell counts were converted to area values (in ha) by multiplying by four. The results were compared using MS excel.

Results

The outputs of Scenarios 1&2 can be seen in figures 3 & 4. In Scenario 1 development disperses widely across the study area, there is some merger of formerly separate towns and coastal regions are subject to high growth. In Scenario 2 development is concentrated close to existing urban centres. Development is less dispersed than in Scenario 1 but the coastal areas are more intensely developed and several agricultural areas proximate to the city are isolated from the wider countryside.
Encroachment upon protected areas

Overall Scenario 1 resulted in the most encroachment upon protected areas, however there were differences on a per county basis; in Scenario 2 protected areas in Dublin were more heavily affected (table 1).

Table 1. Area of urban land within 1km of protected areas by County and Scenario. Values are in hectares.

<table>
<thead>
<tr>
<th>County</th>
<th>2006</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 1/Scenario 2</th>
<th>Difference</th>
</tr>
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<tbody>
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<td>Louth</td>
<td>1712</td>
<td>2500</td>
<td>2412</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>Meath</td>
<td>1444</td>
<td>2816</td>
<td>2172</td>
<td></td>
<td>644</td>
</tr>
<tr>
<td>Dublin</td>
<td>3468</td>
<td>4380</td>
<td>4500</td>
<td></td>
<td>-120</td>
</tr>
<tr>
<td>Kildare</td>
<td>1124</td>
<td>2352</td>
<td>1848</td>
<td></td>
<td>504</td>
</tr>
<tr>
<td>Wicklow</td>
<td>1432</td>
<td>2944</td>
<td>2696</td>
<td></td>
<td>248</td>
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</tbody>
</table>

Figure 3. Comparison of actual GDA land use in 2006 with simulated 2026 land use under Scenario 1 conditions. Actual land use in 2006 is in green (light grey), simulated additional urban development by 2026 is in blue (dark grey).

Figure 4. Comparison of actual GDA land use in 2006 with simulated 2026 land use under Scenario 2 conditions. Actual land use in 2006 is in green (light grey); simulated additional urban development by 2026 is in blue (dark grey) and red is reduced rural settlements. While development is dispersed somewhat, it is consolidated into several growth centres.
Discussion

These two examples used illustrate the potential of MOLAND to visualise differing policy decisions, identify potential issues before they occur and structure policy accordingly. The continuation of current trends represented in Scenario 1 is contrary to Irish national, regional and local policy (Dublin Regional Authority and Mid-East Regional Authority 1999, Government of Ireland 2002, Dublin Regional Authority and Mid-East Regional Authority 2004, Dun Laoghaire Rathdown County Council 2004, Kildare County Council 2005, Meath County Council 2007, Government of Ireland 2009), trends which have lead to several well publicised consequences; urban sprawl, traffic congestion and increased stress to name but a few (O’ Regan and Buckley 2003, European Environment Agency 2006). If development were to further disperse across the region deficiencies could be expected for public services such as waste disposal, education, health provision and emergency service response time (Shahumyan et al. In Press).

Scenario 2 represents a future in line with Irish and European policy (Commission of the European Communities 1990), but it is not without consequence. By pursuing a policy of “compaction” protected sites near the main urban area of the region are more heavily impacted than in the business as usual scenario. This could be considered acceptable given the mitigation of impacts elsewhere but it must be borne in mind, especially as impacts on these protected sites could constitute a breach of the E.U. Habitats, Birds and/or Water Framework Directives.

Further examples of UEP scenario development can be found at www.uep.ie.

References