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Simulating Urban Encroachment upon Natura2000 Sites Using the MOLAND Model: Supporting Appropriate Assessment

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Abstract

The urban fabric of the Greater Dublin Area (GDA) has expanded rapidly over the past 20 years. This has led to a decrease in environmental quality throughout the region and disturbance of protected areas. In an effort to guide development toward a more sustainable path in the region the “Strategic Planning Guidelines for the Greater Dublin Area” were introduced in 1999. These were updated in 2004 as the “Regional Planning Guidelines: Greater Dublin Area 2004-2016” and are currently in the process of another review to become the “Regional Planning Guidelines: Greater Dublin Area 2010-2022”. As part of the review an Appropriate Assessment was undertaken to evaluate the effect of several potential settlement patterns on the region’s protected areas. The MOLAND model was used to simulate four scenarios of possible future settlement patterns for the GDA. These four scenarios were then evaluated in terms of the impact of development on protected areas within the region.

Keywords: *Natura 2000 sites; Appropriate Assessment; Greater Dublin Region; MOLAND model*

1. Introduction

The rapid expansion of urban areas throughout the Greater Dublin Area (GDA) has impacted the environment of the region, affecting people and wildlife (European Environment Agency 2006). In response to these pressures Regional Planning Guidelines have been created in attempt to guide development toward a more sustainable and prosperous path in the future (Dublin and Mid-East Regional Authorities 1999, 2004). These guidelines were initially introduced in 1999 as the “Strategic Planning Guidelines for the Greater Dublin Area” (Dublin and Mid-East Regional Authorities 1999) and updated in 2004 to become “Regional Planning Guidelines: Greater Dublin Area 2004-2016” (Dublin and Mid-East Regional Authorities 2004). To ensure their continued relevance the RPGs must be reviewed not later than six years after the making of the guidelines i.e. by 2010 (Government of Ireland 2000). Beginning in 2009 the Dublin and Mid East Regional Authorities (D&MERAs) began conducting the Review of the RPGs. As part of the Review several environmental assessments are being conducted to assess the impact of the implementation of the guidelines. In addition to Strategic Environmental Assessment (SEA) (Brennan et al. 2009) and Coastal Flooding Risk Assessment, the Review also includes an Appropriate Assessment of the effects of implementing the Guidelines on Natura2000 sites which is in line with Articles 6(3) and 6(4) of the Habitats Directive (European Union 1992). Stages 1 & 2 (Screening and Appropriate Assessment) of the Appropriate Assessment process were carried out by Natura Environmental Consultants, while Stage 3 (Evaluation

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of Alternatives) was carried out with the assistance of the Urban Environment Project (UEP) using the MOLAND model (Shahumyan et al. 2009) to estimate the encroachment of development upon Natura2000 sites under four scenarios describing four possible future development patterns.

The following scenarios were evaluated as part of the Appropriate Assessment:

1. *Baseline/Continued Trends Approach* - This Scenario explores the consequences of continuing the current settlement patterns, whereby actual settlement patterns have diverged from RPG policy (Convery et al. 2006).
2. *Finger Expansion of Metropolitan Footprint* -Development is focused within the metropolitan footprint (MF), with minimal growth in other areas and expansion of the metropolitan footprint along key transport corridors.
3. *Consolidation of Key Towns & the City* - Scenario 3 explores a settlement pattern similar to that proposed in the original Strategic Planning Guidelines (SPGs) published in 1999 (Dublin and Mid-East Regional Authorities 1999). This settlement pattern entails development to be consolidated within the existing MF and a small number of development centres along major transport routes. The metropolitan footprint is not expanded along these corridors.
4. *Consolidation & Sustainability and some expansion at nodes on Transport Corridors* - In Scenario 4 dispersal of development is managed by focusing new growth within the existing MF and several development centres across the region. Strictly enforced Strategic Green Belts were used to prevent the merger of towns and ensure corridors remained between urban and rural natural areas.

2. Methodology

2.1 MOLAND and Scenario descriptions

Full details of the MOLAND model and Scenario descriptions can be found in the report “Regional Planning Guideline review: using MOLAND as part of the Strategic Environmental Assessment Process” delivered to D&MERA (Brennan et al. 2009) and in the MOLAND Model Calibration report (Shahumyan et al. 2009).

Briefly, Scenario 1 explores a continuation of the current, dispersed settlement pattern, where divergence between policy and practice has been noted in the literature (MacLaran and Williams 2003).

In Scenario 2 the effects of a firm policy of consolidation are explored. Development is strongly directed toward an expanded MF, which is extended along key transport corridors and all Transport 21 links (www.transport21.ie) are implemented. Two sub-scenarios were modelled; Transport 21 links implemented in 2016 (1st sub-scenario) or 2020 (2nd sub-scenario).

Scenario 3 explored a strong consolidation policy, whereby growth was focused within the existing MF and towards a limited number of key towns in the Hinterland. A selection of key Transport 21 links were implemented in 2016. In consultation with D&MERA, two versions of the proposed Outer Orbital Route (short- and long-OOR) were implemented as sub-scenarios.

In Scenario 4 simulation consolidation is once again promoted; development is focused within the existing MF and key towns. Key Transport 21 links were implemented in 2016 to enhance

connectivity between the MF and towns. Again two versions of the proposed Outer Orbital Route (short- and long-OOR) were implemented as sub-scenarios. Although consolidation within the existing MF was a focus of this scenario, there was a drive to keep towns distinct from one another. With this taken into consideration several strictly enforced Strategic Green Belts are included in Scenario 4 whose function is to prevent the merger of towns/areas distinct in 2006.

2.2 Encroachment on Natura2000 sites

To investigate the extent of encroachment upon Natura2000 sites, maps of all Special Protected Areas (SPA) and Special Areas of Conservation (SAC) within the study area were loaded into GIS (Figure 1). A special tool (UEP Buffered Cell Count Tool) was developed using ArcGIS Model builder to calculate cell statistics within 1km of these areas. The total encroachment upon Natura2000 sites was calculated for each Scenario and for each SAC/SPA by analysing the difference in landuse within 1km of the sites in 2006 and the simulated landuse in 2026 produced by the MOLAND model. These results then were exported and compared in MS Excel. For each Scenario the location of the top ten encroached SACs and top ten encroached SPAs were noted and the mean encroachment per site was found using the formula: $\Sigma \text{encroachment of site} / \text{no. of sites}$.

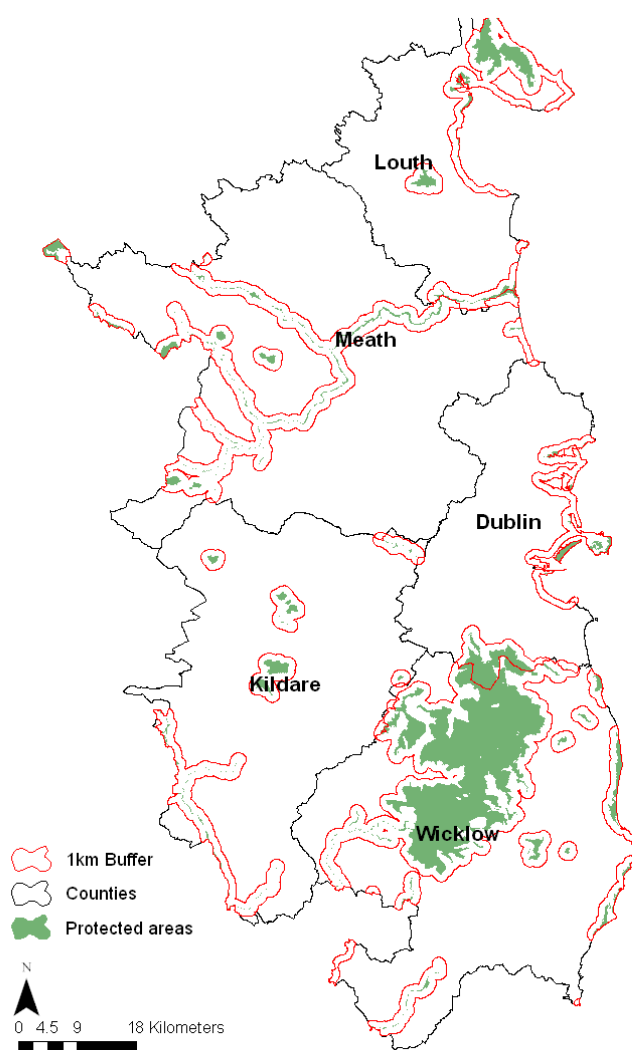


Figure 1 – Protected areas within the study area.

3. Results

3.1 Scenario outputs

The simulated landuse maps for 2026 for each Scenario were compared with actual land use map of 2006 presented in Figure 2. The comparison results are shown in Figures 3 & 4. Full details of the outputs of the Scenarios can be found in the report “**Regional Planning Guideline review: using MOLAND as part of the Strategic Environmental Assessment Process**” delivered to D&MERA (Brennan et al. 2009).

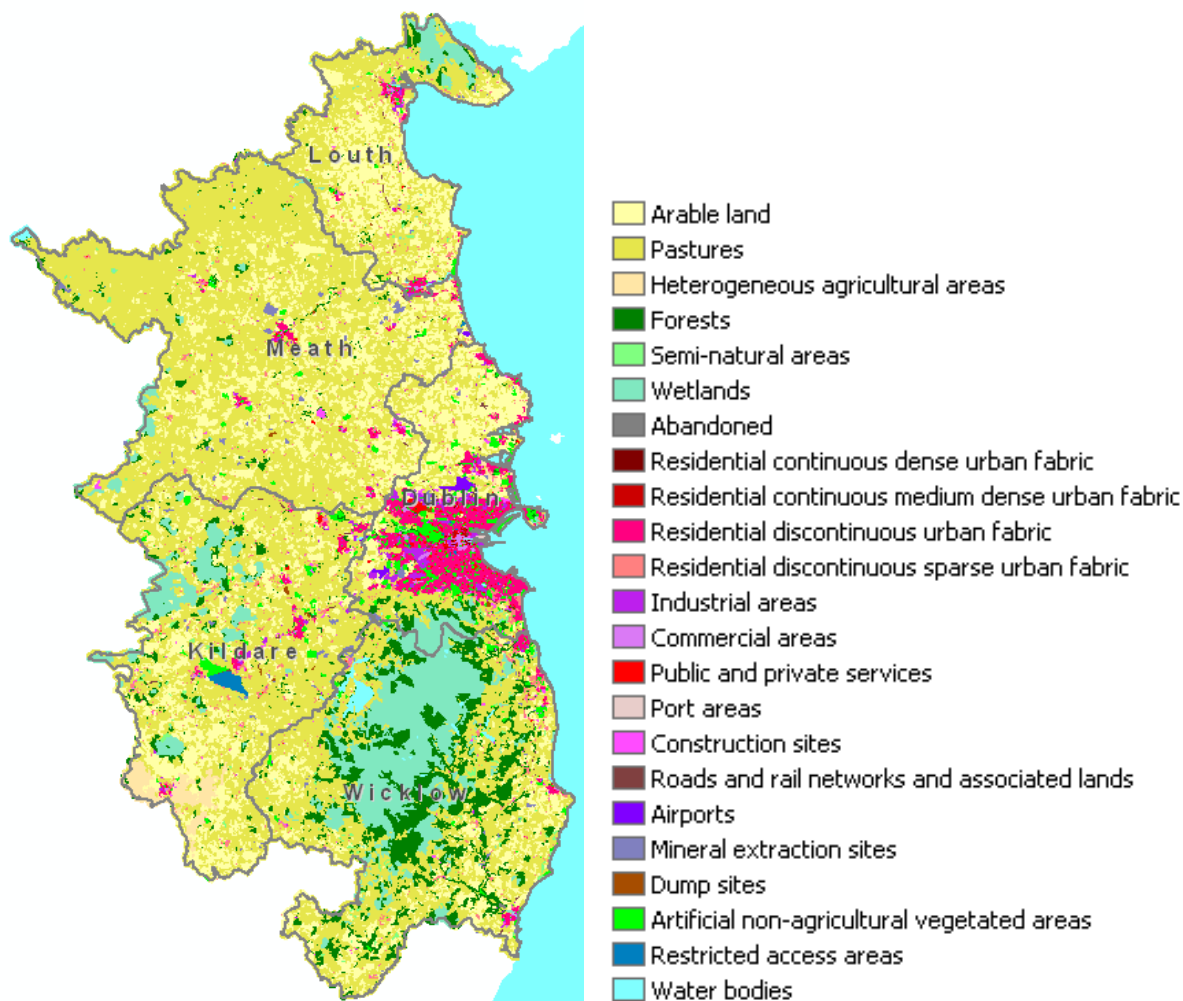


Figure 2 – Actual 2006 land use map of GDR used in MOLAND model.

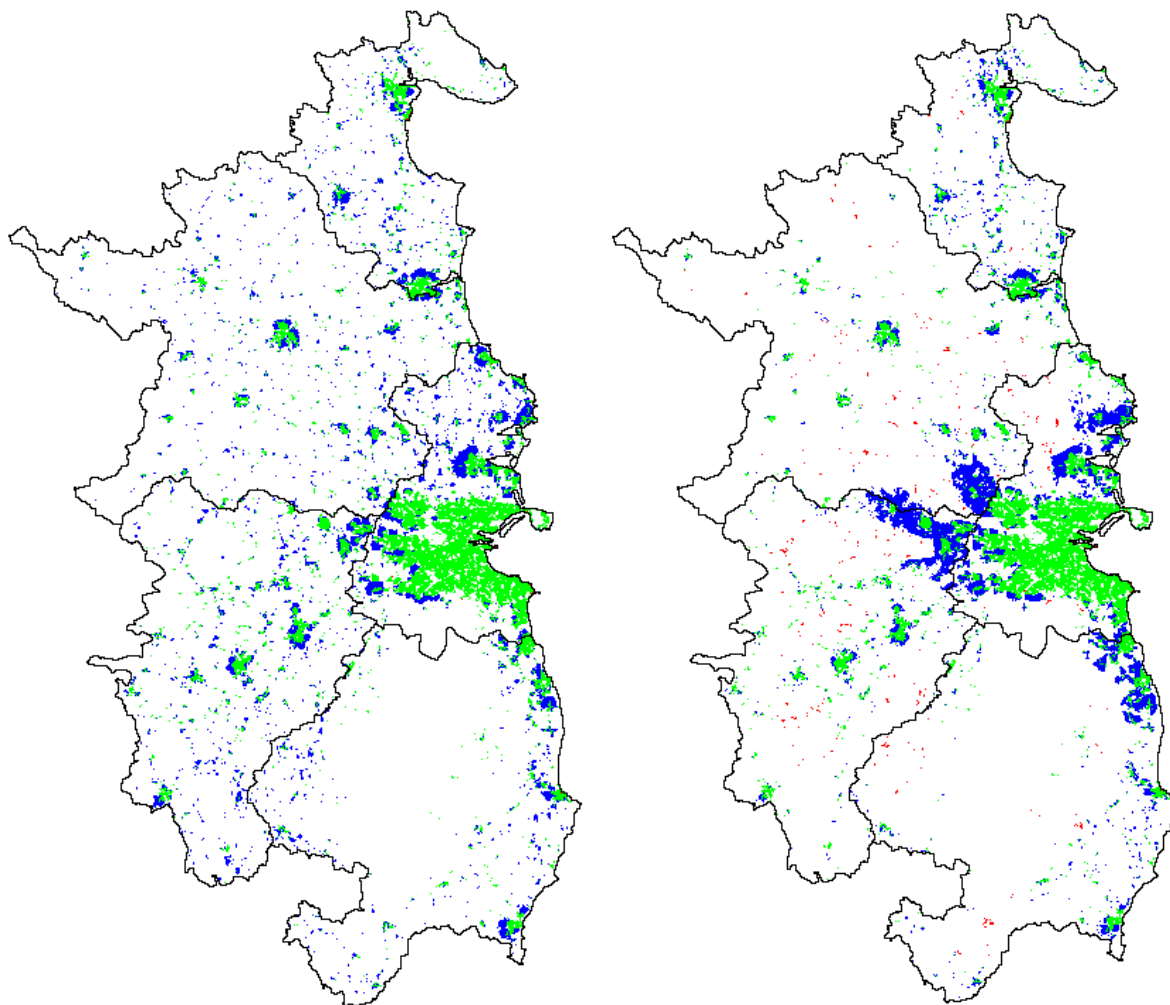


Figure 3. Comparison of actual GDR urban landuse in 2006 with simulated 2026 urban landuse under Scenario 1 (left) & Scenario 2-1 (right) conditions. Actual urban landuse in 2006 is in green; simulated additional urban development by 2026 is in blue and red shows reduced rural settlements.

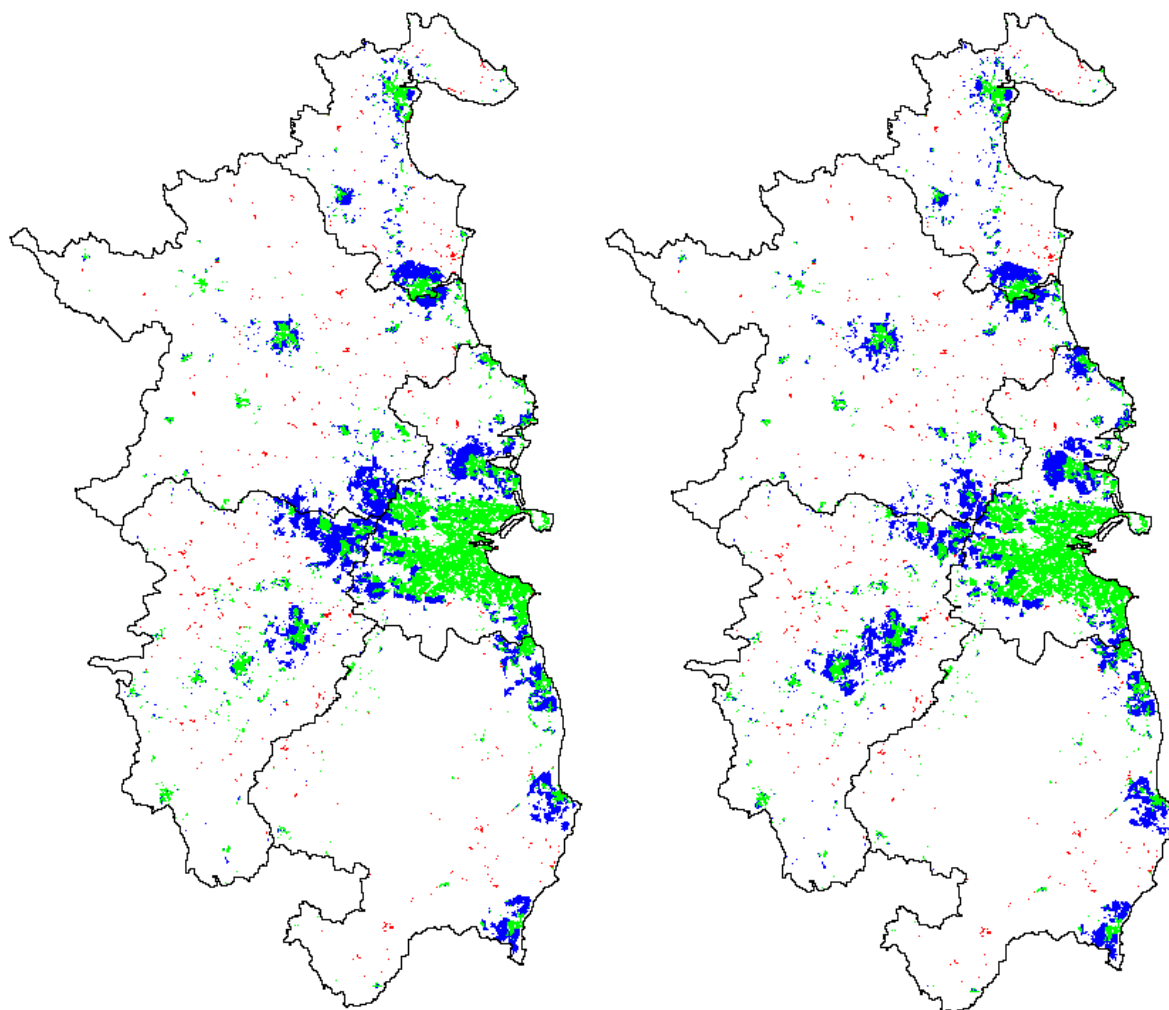


Figure 4. Comparison of actual GDR urban landuse in 2006 with simulated 2026 urban landuse under Scenario 3-1 (left) & Scenario 4-1 (right) conditions. Actual urban landuse in 2006 is in green; simulated additional urban development by 2026 is in blue and red is reduced rural settlements.

3.2 Overall encroachment on protected areas Natura2000 sites

Overall encroachment was most pronounced in Scenario 1, least in Scenario 3 while Scenarios 2 & 4 performed similarly (Figure 5).

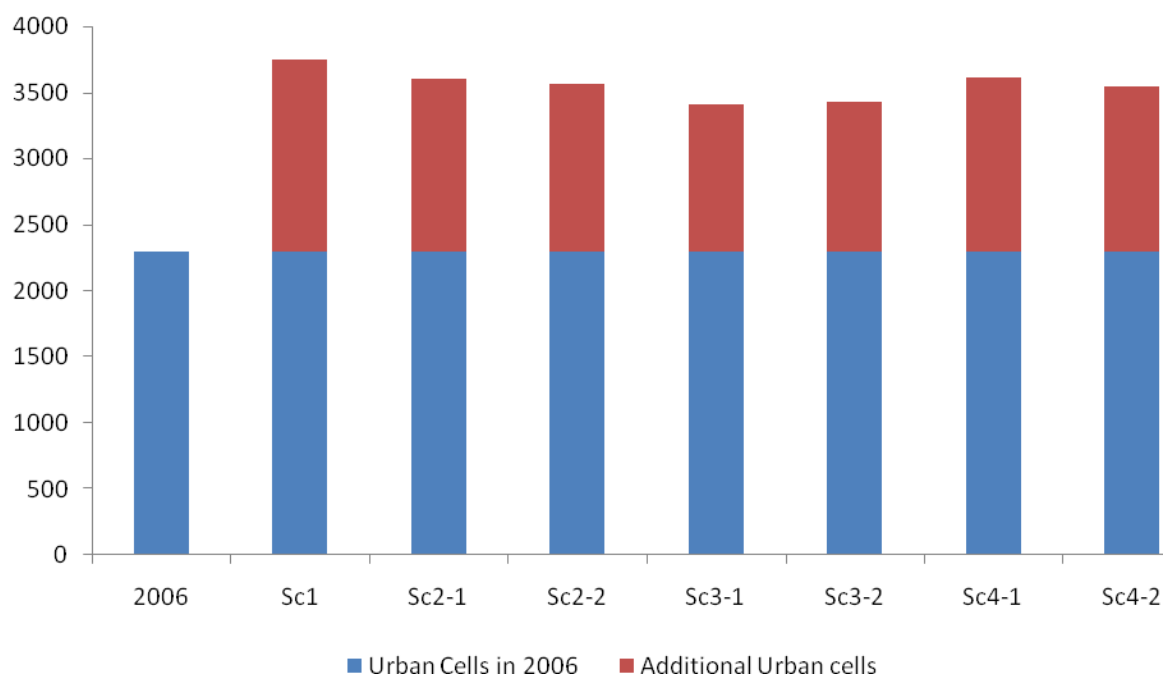


Figure 5. Encroachment of development within 1km of protected areas by scenario. Results are in cell counts.

3.3 Differences between SACs and SPAs

When examined separately differences were observed between SACs and SPAs. SACs followed a pattern analogous to the overall trend (Figure 6), i.e. the most pronounced encroachment was in Scenario 1, least in Scenario 3 and a similar level of encroachment observed for Scenarios 2 & 4.

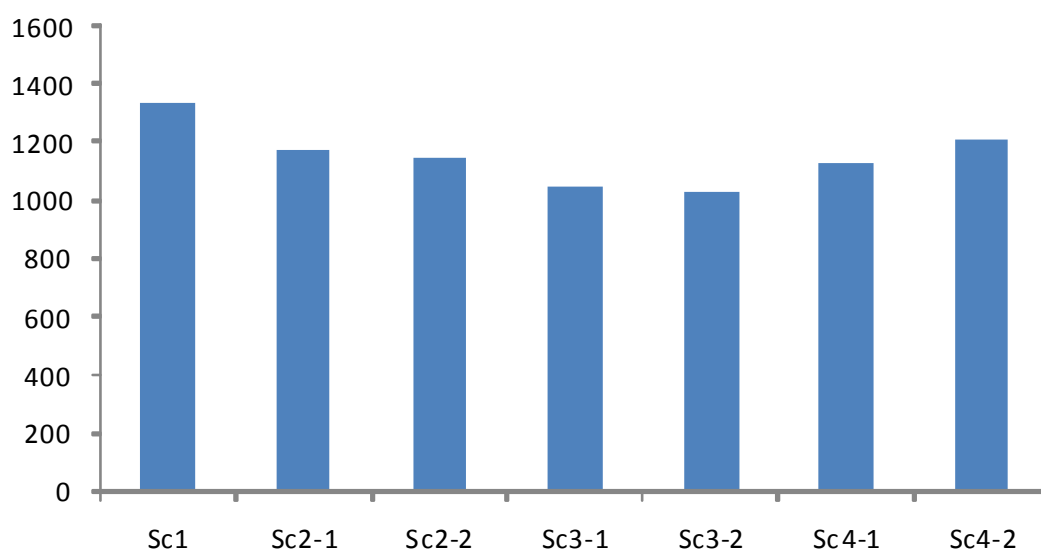


Figure 6. Encroachment of development within 1km of SACs by scenario. Results are in cell counts.

When examined on a site by site basis it was found that development in Scenario 1 encroached upon more SACs than any other Scenario, however the mean encroachment per site was one of the lowest of all Scenarios (Table 1).

Table 1. Number of SACs that experienced some encroachment and mean encroachment (new urban cells within 1km buffer) per site by Scenario.

Scenario	No. of SACs affected	Mean encroachment per site
Sc1	40	33.6
Sc2-1	34	35.5
Sc2-2	36	32.9
Sc3-1	28	39.8
Sc3-2	29	39.0
Sc4-1	32	40.1
Sc4-2	31	39.2

Two SACs consistently experienced heavy encroachment in all Scenarios; these were the *River Boyne and River Blackwater* and *Rye Water Valley/Cartron* (Figures 7 & 8). These SACs were always two of the top three most heavily encroached SACs regardless of Scenario. The *River Boyne and River Blackwater* SAC passes through both Drogheda and Navan towns, while the *Rye Water Valley/Cartron* SAC is proximate to Leixlip in particular and the Dublin Metropolitan Area in general, so both sites could be expected to be exposed to development pressure as growth in these towns is in line with government policy (Dublin Regional Authority and Mid-East Regional Authority 2004).

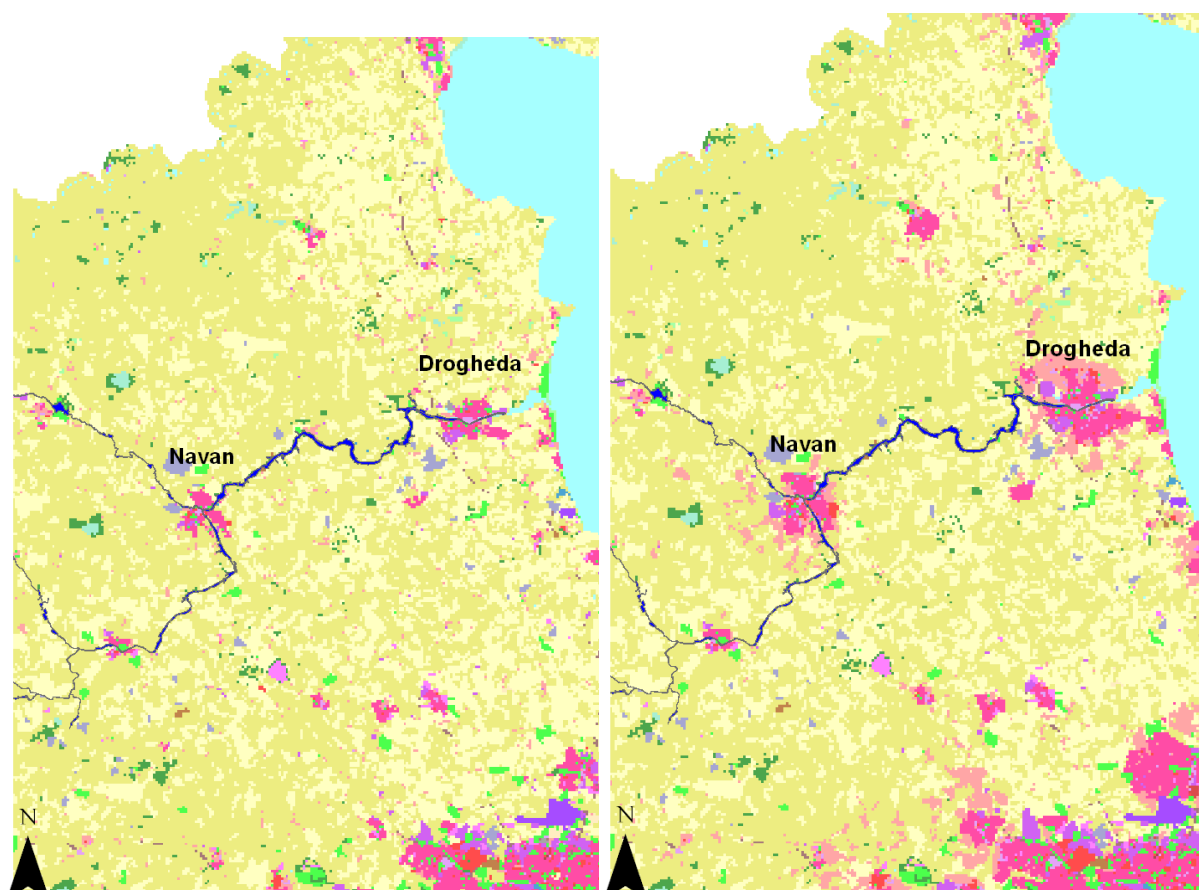


Figure 7. The *River Boyne and River Blackwater* SAC alongside actual landuse in 2006 (left) and simulated landuse in 2026 (right). Scenario 4, sub-scenario 2 displayed for landuse in 2026.

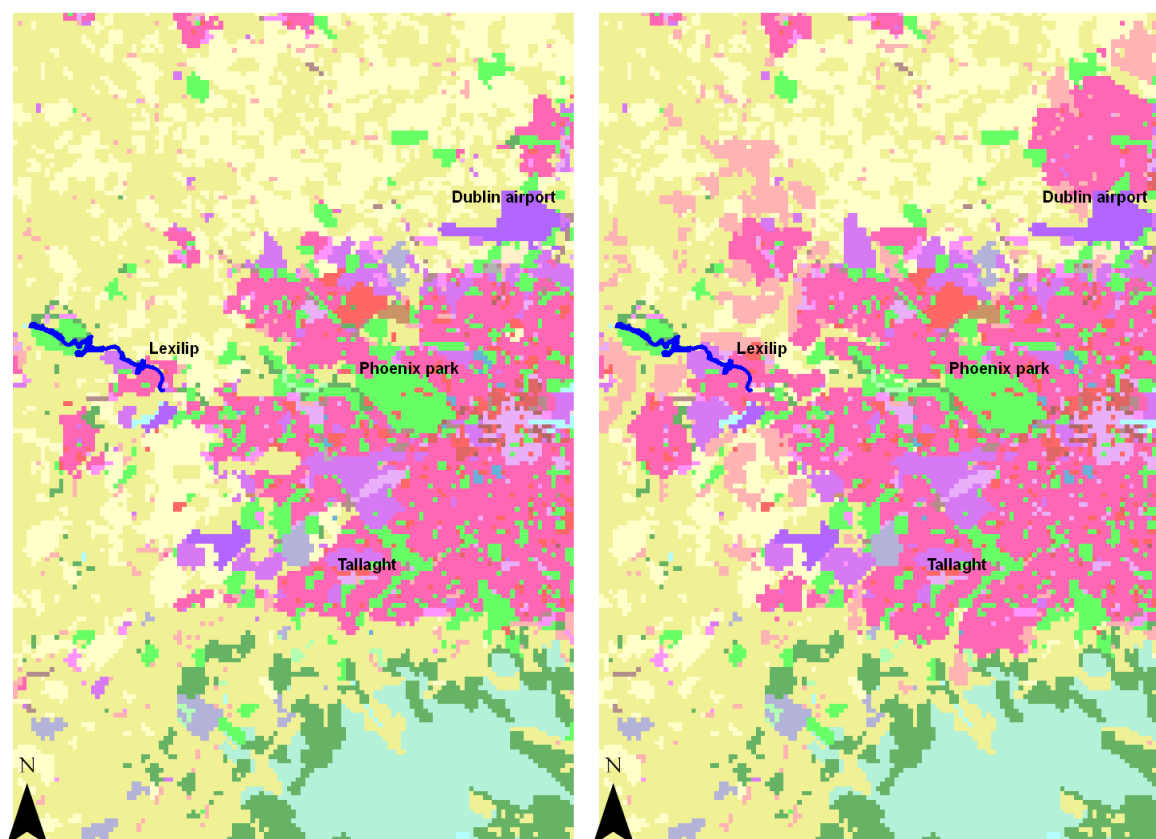


Figure 8. The *Rye Water Valley/Carton* SAC alongside actual landuse in 2006 (left) and simulated landuse in 2026 (right). Scenario 4, sub-scenario 2 displayed for landuse in 2026.

Other SACs which were severely encroached upon were *Pollardstown Fen*, *Dundalk Bay*, *The Murrrough Wetlands*, *Rogerstown Estuary*, *Malahide Estuary* and *Glen Of The Downs*. Coastal SACs tended to be more heavily encroached upon than non-coastal SACs, for example *Rogerstown Estuary*, *Malahide Estuary*, *Dundalk Bay*, *Baldoyle Bay* and coastal sections of the *River Boyne* (Figure 9).

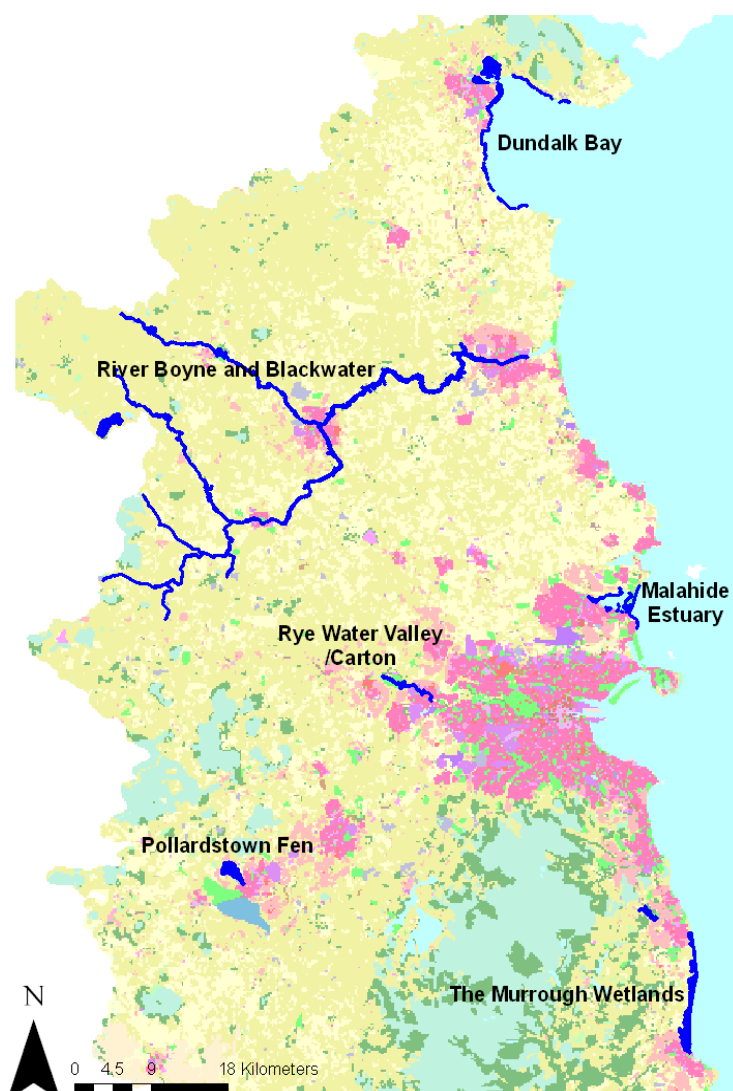


Figure 9. The SACs most heavily affected by development in all scenarios (Scenario 4, sub-scenario 2 displayed).

The pattern of encroachment upon SPAs was dissimilar to that seen in SACs and overall. SPAs were most heavily encroached upon in Scenario 2, Scenarios 3 & 4 perform similarly and encroachment is *least* in Scenario 1 (figure 10).

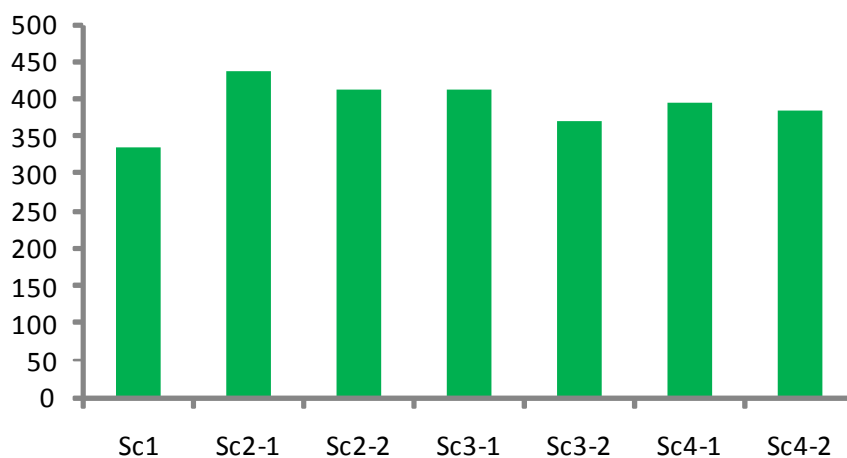


Figure 10. Encroachment of development within 1km of SPAs by scenario. Results are in cell counts.

Differences between Scenarios in terms of the numbers of sites encroached upon were small (Table 2).

Table 2. Number of SPAs that experienced some encroachment and mean encroachment (new urban cells within 1km buffer) per site by Scenario.

Scenario	No. of SPAs affected	Mean encroachment per site
Sc1	14	24.2
Sc2-1	14	31.4
Sc2-2	16	26.1
Sc3-1	11	32.8
Sc3-2	12	39.2
Sc4-1	12	30.9
Sc4-2	13	34.5

Again, regardless of Scenario, two SPAs were consistently in the top three most heavily encroached sites; these were *The Murrough* and *Broadmeadow/Swords Estuary* (Figure 11). Similarly to the most heavily encroached SACs these sites are proximate to growing urban centres (Wicklow and Swords respectively) which could be expected to undergo growth under a wide variety of policies.

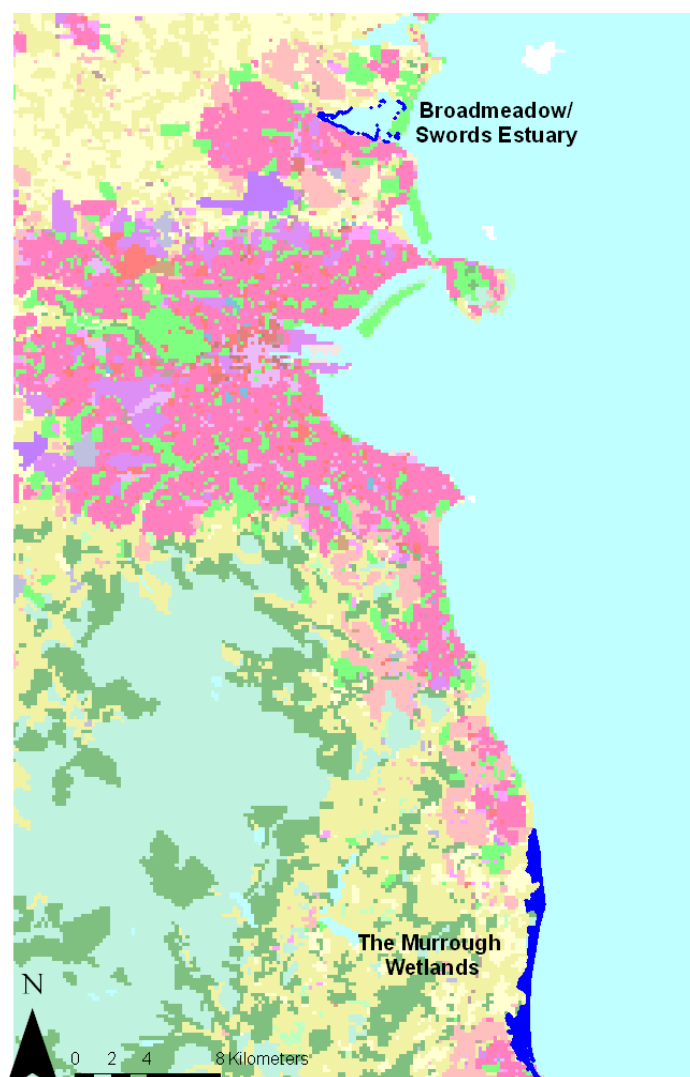


Figure 11. The SPAs most heavily affected by development in all scenarios (Scenario 4, sub-scenario 2 displayed).

4. Discussion

In all Scenarios simulations show that Natura2000 sites within the region will experience encroachment to a greater or lesser extent by 2026. The encroachment of development upon protected sites is a cause for concern from a number of different perspectives. Firstly as urban areas spread the construction projects involved can disrupt the wildlife within these sites (Burton et al. 2002a, Burton et al. 2002b, Burton et al. 2006). Secondly as human populations increase near sites disturbance from increased human visitors can be expected to increase (René J.H.G. Henkens et al. 2006, Holm and Laursen 2009). Finally as urban areas expand and surround sites, the sites themselves can become increasingly isolated from each other resulting in declines in species numbers and diversity (Wenzel et al. 2006)

From an overall perspective encroachment was most pronounced in Scenario 1 and least in Scenario 3 while Scenarios 2 & 4 performed similarly. However this masks two important factors that are worth considering. Firstly, while more sites were encroached upon and total encroachment was higher in Scenario 1 than in the other Scenarios, the dispersed nature of the simulated development in Scenario 1 results in a lower mean encroachment per site than all other Scenarios with regard to SPAs and all others except Scenario 2-2 with regard to SACs.

Secondly coastal sites, particularly SPAs, tended to be more heavily encroached upon in Scenarios 2, 3 & 4 compared to Scenario 1. This is a reflection of the consolidation policies of these Scenarios, whereby new development is encouraged near the existing MF, which borders the coast, and key towns, many of which are coastal. Besides ecological effects this may have implications for Ireland's European obligations under the Birds & Habitats Directives.

These results raise questions regarding how best to protect Natura2000 sites. For example, is it preferable to reduce overall encroachment, resulting in a few heavily impacted sites; or allow development to disperse widely, and reduce mean encroachment per site?

5. Conclusion

The four Scenarios presented here represent hypothetical end points of different policy directions and highlight the complexity of spatial planning at a regional level. There are associated costs and benefits with pursuing any of these paths and the selection of strategic planning policy is in the hands of policy makers and decision makers combined with public participation.

The Greater Dublin Area has undergone rapid change in the recent past (McInerney and Walsh 2009) and recent literature has noted a divergence between policy and practice (MacLaran and Williams 2003, Scott et al. 2006). This underpins the importance and usefulness of tools which allow for alternative futures to be simulated and for these possible outcomes to inform policy development. The MOLAND model allows policy options to be evaluated before concrete decisions are made and provide a useful basis for discussions around the potential impacts of specific policy options on environmentally sensitive sites and in particular sites protected by European legislation.

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All work undertaken on the MOLAND model, for the Greater Dublin Region is subject to the license conditions of the software developers, Research Institute for Knowledge Systems b.v. (RIKS b.v.) and the data set owners, DG JRC under license no. JRC.BWL.30715.

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