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GIS Applied to Landslide Hazard Mapping and Evaluation in North-East Wales

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Slope instability is a significant environmental hazard in North-East Wales, responsible for important damage to roads and built-up areas. During the late 1980s and the 1990s, systematic landslide mapping and hazard modelling was completed for a number of landslide prone areas within Great Britain, but no such study has to date been carried out for North Wales. This research reports on the creation of a digital landslide inventory for North-East Wales and the use of a Geographical Information System (GIS) to create the first landslide susceptibility models for the area.

The research has resulted in the most comprehensive landslide inventory of North-East Wales completed to date. This was accomplished through a combination of aerial photograph interpretation, field mapping and data collection from secondary sources (e.g. consultancy reports, newspapers), yielding a database that records 430 landslides for the area. This represents a 76% (186 landslides) increase on the number of landslides recorded for the area in the UK national landslides database. The landslides in North-East Wales are almost entirely situated inland, with less than 1% on the coast. Approximately 84% of the landslides occur within drift geology and 16% in solid geology. For the slides of known type, 46% are translational slides, 47% rotational slides, 3% flows, 3% falls and 1% complex failures. The type and distribution of landsliding in the area shows notable differences to that found in areas of similar bedrock geology elsewhere in the UK (e.g. Derbyshire and South Wales).

Analysis shows that the main landslide controlling parameters in North-East Wales are: lithology, drift material, slope angle, proximity to known faults (structural weaknesses) and proximity to fluvial channels (undercutting). These factors were weighted statistically based on their estimated contribution to slope instability, and combined to create the landslide susceptibility models using a statistical (multiple logistic regression) approach. The resulting models divide the landscape of North-East Wales into areas of ‘low’, ‘moderate’ and ‘high’ landslide susceptibility using calculated probability values. These models indicate that 8% of the surface exposure of drift deposits and 12% of the area of solid geology are classified as being of high or very high susceptibility to slope instability. Validation of the models indicates that they have success rates of up to 80% in predicting the location of known (documented and mapped) landslides. This compares very favourably to models produced elsewhere.

The usefulness of the models as a landslide management tool has also been explored by carrying out a landslide impact survey for built-up areas of Holywell and Greenfield Valley in the north of the study area, where there are a number of well defined (‘known’) landslides. The landslide impact survey highlights that damage to the built environment extends beyond these known landslides into areas indicated by the models as being of high and very high susceptibility to slope instability. This emphasises the value of GIS techniques, incorporating direct and indirect landslide mapping, in landslide susceptibility modelling and associated landslide management.