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Remote Sensing and GIS for Landuse/Landcover Classification and Water Quality in the Northern Ireland

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This study presents landuse/landcover (LULC) classifications of Northern Ireland in order to quantify land-use types driving chemical loading in the surface water bodies. The major LULC classes are agricultural land, bare land (mountainous areas), forest, urban areas, and water bodies. Three ENVISAT ASAR multi-look precision images acquired in 2011 and two Enhanced Thematic Mapper Plus (ETM+) acquired in 2003 were used for classification. The ASAR digital numbers were converted to backscattering coefficient (sigma nought) and enhanced using adaptive Gamma filter and Gaussian stretch. Supervised classifications of Maximum Likelihood, Mahalanobils Distance, Minimum Distance, Spectral Angel Mapper, Parallelepiped, and Winner Tercat were applied on ETM+ and ASAR images. A confusion matrix was used to evaluate the classification accuracy; the best results of ETM+ and ASAR were given by the winner classification (82.9 and 73.6 %), and maximum likelihood (81.7 and 72.5 %), respectively. Change detection was applied to identify the areas of significant changes in landuse/landcover over the last eight years. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) digital elevation model was processed to extract the drainage systems and watersheds. Water quality data of the first and second order streams were extracted from 2005 survey by Geological Survey of Northern Ireland. GIS spatially distributed modelling generated maps showing the distribution of phosphorus (P), nitrate (NO_3), dissolved organic carbon (DOC), and some of the trace elements including fluoride (F), calcium (Ca), aluminium (Al), iron (Fe), copper (Cu), lead (Pb), zinc (Zn), and arsenic (As) across the watersheds of the Northern Ireland were generated. The distribution of these elements was evaluated against the LULC classes and bed rock geology. Concentration of these elements was classified into normal (safe level), moderate, high, and very high based on the World Health Organization (WHO, 2011) water quality standards. The results show that P concentration is generally high across all the watersheds. NO_3 is within normal range in all watersheds. DOC is within normal range in urban areas, moderate to high in agricultural lands, and high in the forest areas and bare lands. F and Fe are within safe level in all watersheds. Al, Cu, and As are high in all watersheds around the bare land LULC class which are underlain by psammite and semipelite metamorphic rocks. Ca is within normal range in most of watersheds but it is high in the south western part of the study area because of the presence of limestone bedrock. Pb and Zn are within normal range in the urban and most of the agricultural land, and high in the mountainous areas underlain by psammite and semipelite metamorphic bed rock.