# Digital Soil Mapping in the Irish Soil Information System

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There is a growing need in Europe to support policy-makers with a harmonised soil information system and the current status of available information on soils in Europe is inconsistent at best. A soil map and information system at the scale of 1:250,000 has been identified by the EU as an economically feasible intermediate scale and the proposed approach must take into consideration existing methodologies, e.g. the SOTER project (Dobos et al., 2005), and Directives, e.g. the INSPIRE directive, [Directive 2007/2/EC, Infrastructure for Spatial Information in the European Community]. Harmonised soil data across Europe with a 1:250 000 geo-referenced soil database will allow for exchange of data across member states and the provide the information needed by the European Commission and European Environment Agency for reporting on issues relating to soil quality under a future Soil Framework Directive. Within this context, the Environmental Protection Agency of the Republic of Ireland commissioned a project run by Teagasc to produce a 1:250 000 soil map of the Republic of Ireland. Delivery of this map and associated database is a collaborative effort between Teagasc, the National Soil Resources Institute at Cranfield in the UK and University College Dublin.


Figure 1 Map of the Rep. of Ireland organized by counties

In Ireland, a complete set of soil information at the target scale identified at European level (1:250 000) does not exist. Results from a study by Daly and Fealy (2007) indicate that the soil data coverage of Ireland is incomplete in both detail and extent. This has created difficulties for users of Irish soil information and has often led to inappropriate use of soil data. The General Soil Map of Ireland only provides a highly generalised and often inappropriate level of information for the many national applications for which it is used. The overall objective the Irish Soil Information System (ISIS) is to conduct a programme of structured research into the distribution of soil types over the whole of Ireland and construct a soil map, at 1:250 000 scale, which will identify and describe the soils according to a harmonised national legend. The project contains a unique combination of soil taxonomic efforts and digital soil mapping which will inform subsequent field work by pedologists to generate the 1:250 000 soil map of the republic.

The project will begin with an intensive study and analysis of the areas surveyed in detail that cover 44% of Ireland (Terra Cognita). Soil class criteria will be reviewed and redefined where appropriate to augment the current Irish soil classification. The General Soil Map (GSM) of Ireland currently comprises 367 soil series and surveys of an additional four counties, surveyed since the production of the GSM, have identified a further 112 soil series. This classification will have to rationalized to produce a consistent, robust soil classification on which to base the 1:250,000 soil map. This classification will be correlated to wider international soil classification standards, principally the World Reference Base classification (WRB) (FAO, 1998; 2006).

As the soil classification is rationalized, parallel efforts will be placed in generating predictive model of the soil series of Ireland with a view to informing the subsequent field programme (Digital Soil Mapping). These efforts are divided into a number of key phases of activity, each designed to determine the most robust preliminary landform classification that will form a key resource for the following field programme. In first phase, the methodologies proposed will address and assess two different approaches available for predictive soil mapping as suited to the Irish context; i) Physiographic Soilscapes mapping and ii) Digital Soil Mapping (such as Stratification, Soil association level analysis, Soil series level analysis and Features space analysis).

### Physiographic Mapping

As there is no physiographic map for Ireland, a first impression of the landscape units will be obtained using a combination of a modified Hammond approach (Figure 2), Iwahashi and Soter. This can be implemented relatively quickly. More sophisticated approaches will be applied, such as a modified LENZ approach. This is a hierarchical system for mapping land environments based on data on terrain, climate and soil. This method would require a new set of parameters developed specifically for this project and a modified MacMillan hill-shed analysis using LandMapR, in which three different approaches are considered to determine landform units at the national, regional and local scale. The modified MacMillan is a more experimental approach but relies on DTM data which are currently available for Ireland.

### Digital Soil Mapping

The digital soil mapping efforts will be based on those environmental covariates that form part of the Scorpan factors of soil formation (McBratney et al., 2003) and can be used in the soil-landscape analysis. These include terrain, soil (small scale), geology (parent material), climate and land use information. A number of inference techniques will be considered as part of this project including See5, Netica and Random Forests. See5 uses decision trees whereas Netica uses belief networks.

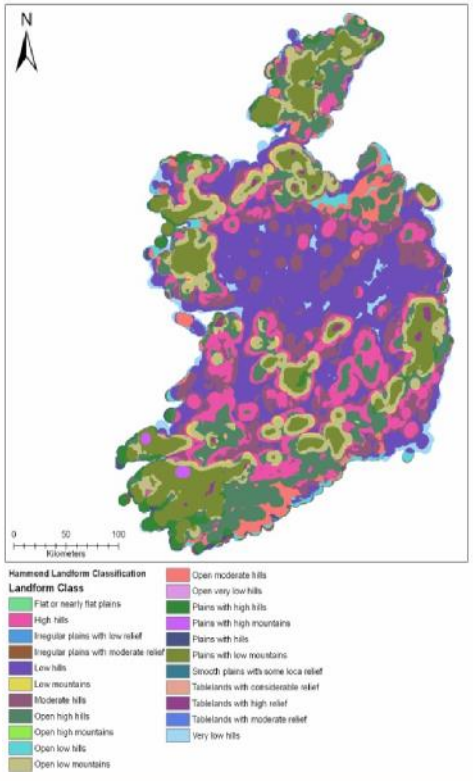


Figure 2 Hammond classification of the Rep. of Ireland

In the second phase of this part of the project, the base delineations for all of the previously unsurveyed area of the country, referred to as terra incognita will be developed. This involves extending the results from the spatial inference engines into areas where the soil information is sparse, about 66% of Ireland. Extrapolation of the modelling efforts will need to consider physiographic units in this landscape, as well as ensuring that there is correspondence in the feature space used for model development. Map unit definitions as well as scale issues will need to be fully considered in this activity. There are a number of existing approaches that may also be considered such as region growing. These approaches will be inventoried and assessed in order to choose the most appropriate and pragmatic method. Validation methods that will be assessed are common methods such as bootstrap, or Jack-knife methods; alternatively we may also consider rates of misclassification to obtain measures of performance for the different approaches.

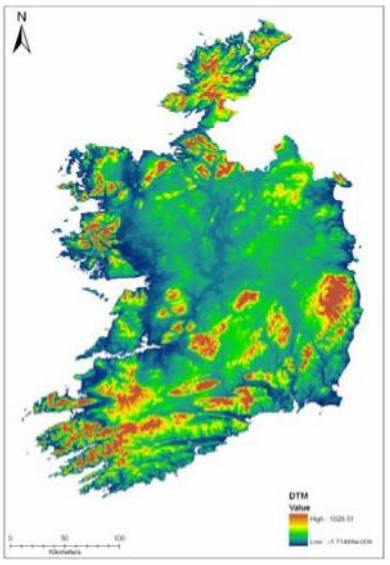


Figure 3 DTM of the Repub. of Ireland

### The SCORPAN covariates

The terrain of the republic is characterized by a hilly interior lowland surrounded by a broken boarder of rugged hills and low mountains to the west and south (Figure 3). The geology of the central plain is predominantly carboniferous limestones (Figure 4). To the northeast of this there are the Lower Palaeozoic shales, grits and greywackes, with limestones and younger shales further east. In the northwest is characterized by a complex mixture of shists, quartzites and granite whereas in the south west and east the geology is generally dominated by Old Red Sandstone. Ireland experienced at least two major glacial episodes, an earlier Munster General Glaciation (200,000 to 130,000 years ago) and the Midlandian General Glaciation (75,000 to 10,000 years ago). There are significant glacial deposits (boulder clay) in the southern quarter of the country associated to the earlier period. The later glacial episode generated extensive drumlin deposits in Ulster and Leinster, eskers in the Kildare, Offaly, Galway and Roscommon and thick sand deposits in Curragh.

There are, in broad terms, nine major soil types iden-

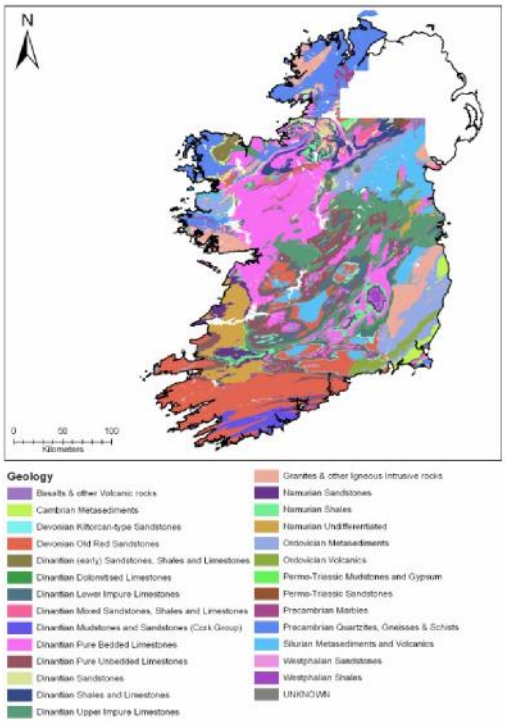


Figure 4 Map of the main geological formations in the Rep. of Ireland

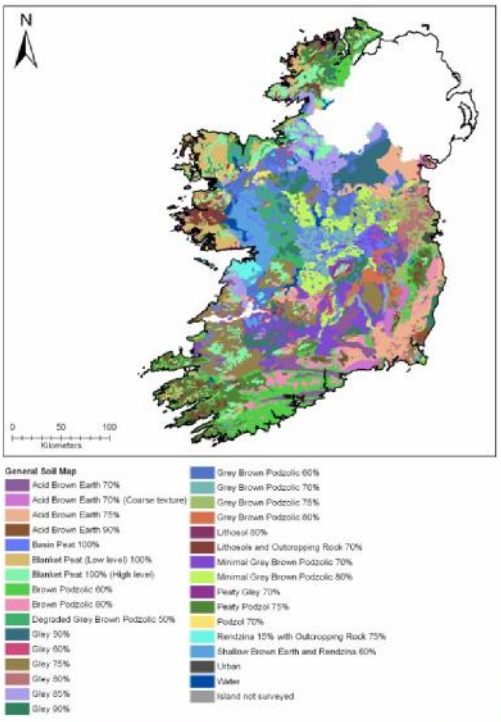


Figure 5 Main Soil groups in the Rep. of Ireland.

tified in the General Soil of Ireland: Podzols, Brown Podzolics, Grey Brown Podzolics, Acid Brown Earths, Brown Earths, Gleys, Rendzinas, Lithosols and Peat. Podozols are typically leached, poorly drained soils that predominate in the mountainous and hill areas; the less depleted Brown Podzolics are mostly observed in the southern and south eastern areas associated with sandstones and shales. Rendzinas and Grey Brown Podzolics are usually formed from calcareous parent material and are therefore primarily found in the central lowlands, underlain by limestone geology. The poorly drained Gleys are often found in association with Basin peat (groundwater dominated) and are found in the central lowlands of Ireland. Blanket peat (rainfall dominated) is found predominately in the western areas of the country and in the upper parts of the mountain ranges. The predominant climate in Ireland is wet and mild, with the majority of precipitation associated to Atlantic systems arriving from the west and moving east. Predominant landuses are pasture, arable, forest or peat (Fay et al., 2007).

The Digital Soil Mapping efforts will inform a field investigation programme on the areas that have not already been surveyed in detail (Terra Incognita). The fieldwork, organized by Teagasc, will focus on boundary checking and map unit composition by examining and describing modal profile pits and auger bores. Representative soil profile pits will need be excavated, sampled and described for soil series for which there is no existing characterization. The field survey should produce the equivalent of approximately 350 map sheets (of 10km x 10km). The result from the various stages of the project will then be integrated in a Soil Information System to deliver the key final map deliverable, the digital polygon based 1:250,000 soil map of Ireland.

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