The Soil Survey and Land Research Centre

by R.I. Bradley

The Soil Survey and Land Research Centre (SSLRC) based on the Silsoe Campus of the Cranfield Institute of Technology is the largest UK centre for national and international research and development, consultancy and training in soils and their interaction with the atmosphere, land use, geology and water resources. It has had the national responsibility for documenting and researching into the soils of England and Wales over the last 50 years and in the last decade has been applying this experience both in the UK and abroad.

What is LandIS?

IN 1979 SSLRC was commissioned by the Ministry of Agriculture, Fisheries and Food (MAFF) to develop a computer-based soil information system to organise existing and new data for England and Wales in an orderly manner, to facilitate their effective use. Subsequently it was expanded to become a national land information system (LandIS) with the addition of climate and other environmental datasets.

LandIS allows the capture, storage, manipulation and retrieval of data on soil and climate, together with other environmental data. It enables users to access information from the Soil Survey's National Soil Map, National Soil Inventory and agroclimatic databases together with derived information about land potential (workability, trafficability, droughtiness, crop suitability). All of the data are geo-referenced according to the Ordnance Survey's National Grid or related to soil series, the basic unit of soil classification.

LandIS objectives

LandIS is designed to:

- handle large volumes of many types of data;
- validate, correct and update data;
- relate different types of data and automatically interpret basic data according to various models;
- interface with other software such as PASCAL, GENSTAT, FORTRAN and SPANS;
- provide a user friendly interface;
- produce output in the form of reports, tables, statistical summaries, maps and graphics.

LandIS can be used in two ways, firstly through a comprehensive screen-menu system for retrieval and manipulation of data in a specific manner. This is done on a daily basis by SSLRC and staff of MAFF. Secondly through a consultancy service operated by the SSLRC Computing and Information Systems Department.

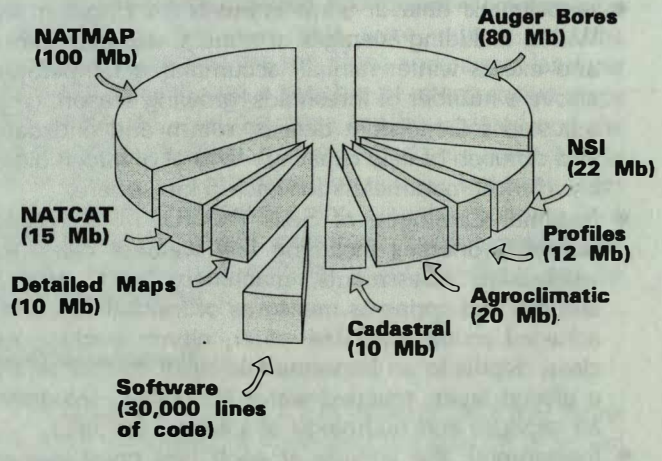


Figure 1. The Land Information System (LandIS): size of datasets.

Hardware and software

LandIS resides on a local area VAX cluster on the Silsoe Campus. The cluster is powered by a VAX 4300 and VAX 4200 with more than 11 Gbytes of mass storage. LandIS data and software occupies about 500 Mbytes on a dedicated disk drive. Remote access is through standard communication networks and the British Telecom's Packet Switch Stream (PSS).

The system has been built around relational structured databases and DEC software comprising Datatrieve, a

fourth generation language for file definition, management, manipulation and retrieval, and a common data dictionary. The menu system is called up by a PASCAL shell and the DEC command language. Retrieval of data in batch mode is a new feature of the system.

Data in LandIS

The major sources of data in LandIS are described below and the relative disk storage requirements in Figure 1.

- the National Soil Map for England and Wales at a scale of 1 : 250,000 (NATMAP) in raster format at 100 m, 1 km and 5 km resolutions;
- the National Soil Inventory (NSI) for England and Wales: descriptions of soil and site at 5 km intervals (6125 sites), together with a range of analytical data relating to topsoils, such as pH, organic carbon, particle-size distribution, total and extractable potassium, phosphorus and magnesium and eleven trace elements, including potential pollutants;
- soil and site descriptions from auger bores (about 170,000) and benchmark profiles (about 2000), originally described in the field in computer compatible form, as part of the National Soil Map, National Lowland Peat Inventory and systematic surveys undertaken since 1979 to produce soil maps at 1 : 25,000 and 1 : 50,000 scales;
- chemical and physical analyses of soil samples taken from the benchmark profiles;
- agroclimatic data at 5 km intervals for England and Wales, including averages of annual, summer, winter and excess winter rainfall, accumulated temperature above a number of thresholds, growing season, crop-adjusted soil moisture deficits, return and end dates and duration of field capacity – a total of fifteen different climatic parameters for each 5 km square;
- National Catalogue of Soils (NATCAT): soil series related properties including soil wetness class, soil workability assessments, machinery work days in autumn and spring as measures of trafficability, crop-adjusted profile available water, nitrate leaching risk class, depths to an impermeable layer, to rock and to a gleyed layer, retained water in topsoils, integrated air capacity and hydrology of soil type (HOST);
- topography: the altitude at each NSI point was recorded in the field from the OS topographic map. Altitude, slope angle and shape are held for all benchmark profiles and slope class was recorded at all auger bore sites. A 5 km altitude dataset was also compiled for the revised Agricultural Land Classification system adopted by MAFF in 1988.
- land use has been recorded at all sites visited and is classified as: ley or permanent grassland, rough grazing, arable, horticultural, deciduous and coniferous woodland, made-up ground, recreational land or 'other' land use types.

Since 1988 SSLRC has used a SPANS GIS to supplement and enhance the modelling and display of its data. Use of the digitising module has enabled vector, raster (especially raster data from LandIS) and point data of various types to be integrated.

Increasingly organisations are recognising the value of adding soil and other environmental data to their own data and SSLRC is regularly involved in the lease of such data tailored to the needs of the client. A leasing scheme is available for most of SSLRC's databases.

SSLRC has been closely involved in the establishment of PC-based information systems for land resource assessments in Jordan and India (both linked to SPANS) and Venezuela. There are current proposals for prototype systems in Czechoslovakia, Poland, Tanzania and Kuwait. SSLRC is also closely involved with programmes funded by the European Community to update digital versions of the EC soil map and compile a community-wide soil analytical database.

In recent years SSLRC has conducted training programmes and currently runs a three month intensive course on computerised land information systems. It is designed for post experience participants who need to organise and manipulate agricultural and environmental data whether resulting from resource assessment, land registry, cadastral surveys or land and management. In 1993 an additional month-long course in applied geostatistics for environmental analysis is planned.

A number of applications have been developed by integrating data from LandIS using the GIS. Four are described here that relate to environmental risk assessment and land suitability. Other land use, management and planning applications are listed in the table below.

Crop suitabilities
Winter wheat
Spring barley
Potatoes
Sugar beet
Vegetables
Intensive grassland
Soft fruit
Sub-tropical fruits
Linseed
Beans
Maize

Hydrolic processes
Winter rain acceptance potential
Hydrology of soil type
Soil water regime
Soil wetness class
Land drainage design

Other land use
Ecological habitat creation
Intensive recreation
Golf course
Ponds and reservoirs
Wheeled vehicle traffic

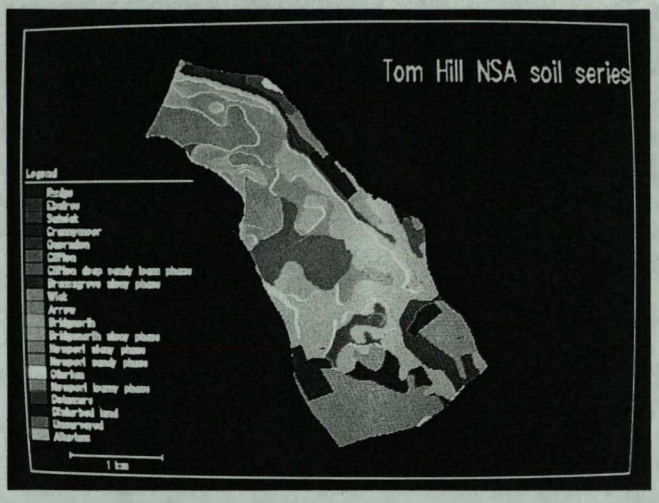
Risk to the environment
Soil erosion by wind and water
Nitrate leaching
Pesticide pollution
Sewage sludge acceptance
Farm waste disposal
Soil salinity
Development of acid sulphate soils
Aquifer vulnerability
Acid rain impacts
Corrosion risk
Soil shrinkage
Compaction

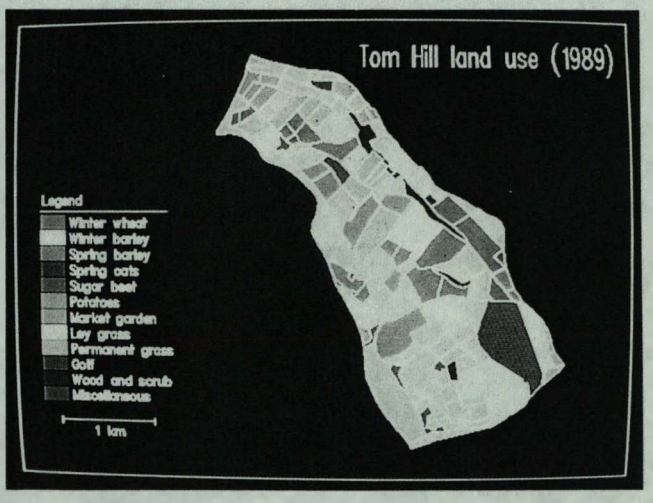
Techniques
Irrigation need and scheduling
Straw incorporation
Sewage injection
Subsoiling and moling
Direct drilling
Earth moving and land restoration

Future strategy
Climate change
Land use change
Land to be set-aside
Effect of decrease in agricultural land subsidy
Land suitability for forestry
Land use in relation to water quality

Nitrate pollution

Detailed soil data collected from a strategic survey of the Tom Hill area on the border of Shropshire and Staffordshire have been combined with data on land use, excess winter or leaching rainfall and the ease of vertical transfer of water (*ie* soil permeability) to assess





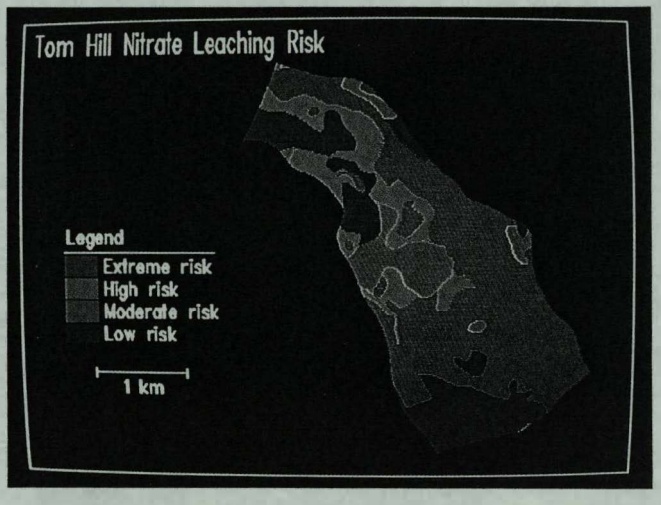


Figure 2. Tom Hill nitrate sensitive area.
a. Soil series from field mapping at 1 : 25,000; b. land use in 1989; c. leaching risk – integration of soil texture and depth to an impermeable layer with depth to rock and a water table.

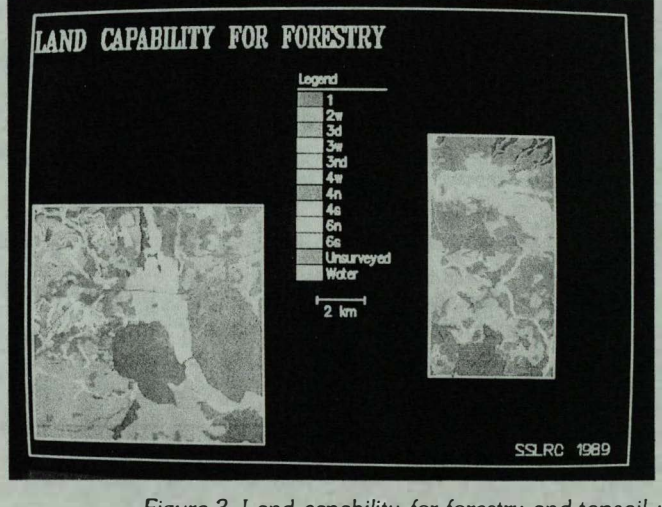
the potential loss of nitrates to ground water. The catchment contains an important borehole operated by Severn Trent plc. Using SPANS a sequence of maps (Figure 2) have been processed which show that, under the present system of land use with relatively high inputs of nitrogenous fertilisers, the concentration of nitrate-N in water leaching from the soil profile is potentially considerably above the EC limit of 11.3 mg N per litre. By changing the land use and inputs of fertiliser, the model can be used to predict the potential changes in the N concentration of the leachate from the catchment offering a decision support system for future policy making.

Applied soil mapping for planning, development and conservation

As part of its Geological and Minerals Planning Research Programme, the Department of the Environment commissioned SSLRC to examine the potential for more extensive use of soils, climatic and land use information in preparing land use planning policies, proposals for development of land and conservation strategies. The study area covered 150 square kilometres near Southampton. The field data were entered into the LandIS database and the soil, slope and current land use maps into SPANS and a number of interpretative maps were produced. The database can be updated and the models used modified as required. The system is thus responsive to both improved knowledge and to changes in recommended practices and planning policies. Two examples of the maps presented, land capability for forestry and soil vulnerability whilst handling, are reproduced in Figure 3.

Shrink-swell

The presence at 1.0 to 1.5 m depth of clays that shrink and swell according to their moisture content is an important factor in the design of foundations and pipelines,



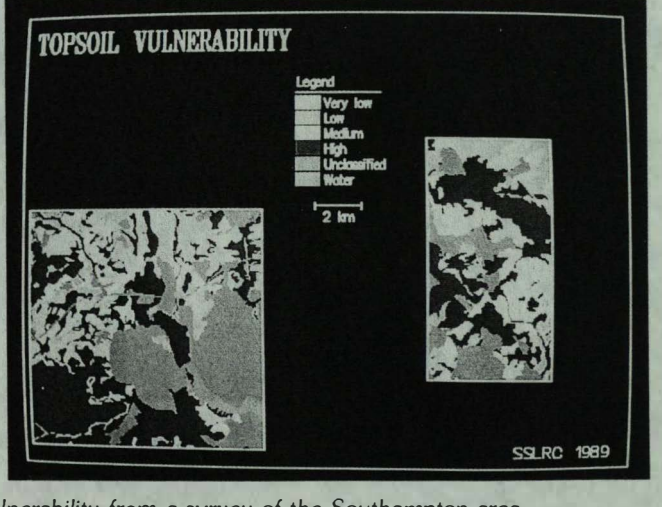


Figure 3. Land capability for forestry and topsoil vulnerability from a survey of the Southampton area.

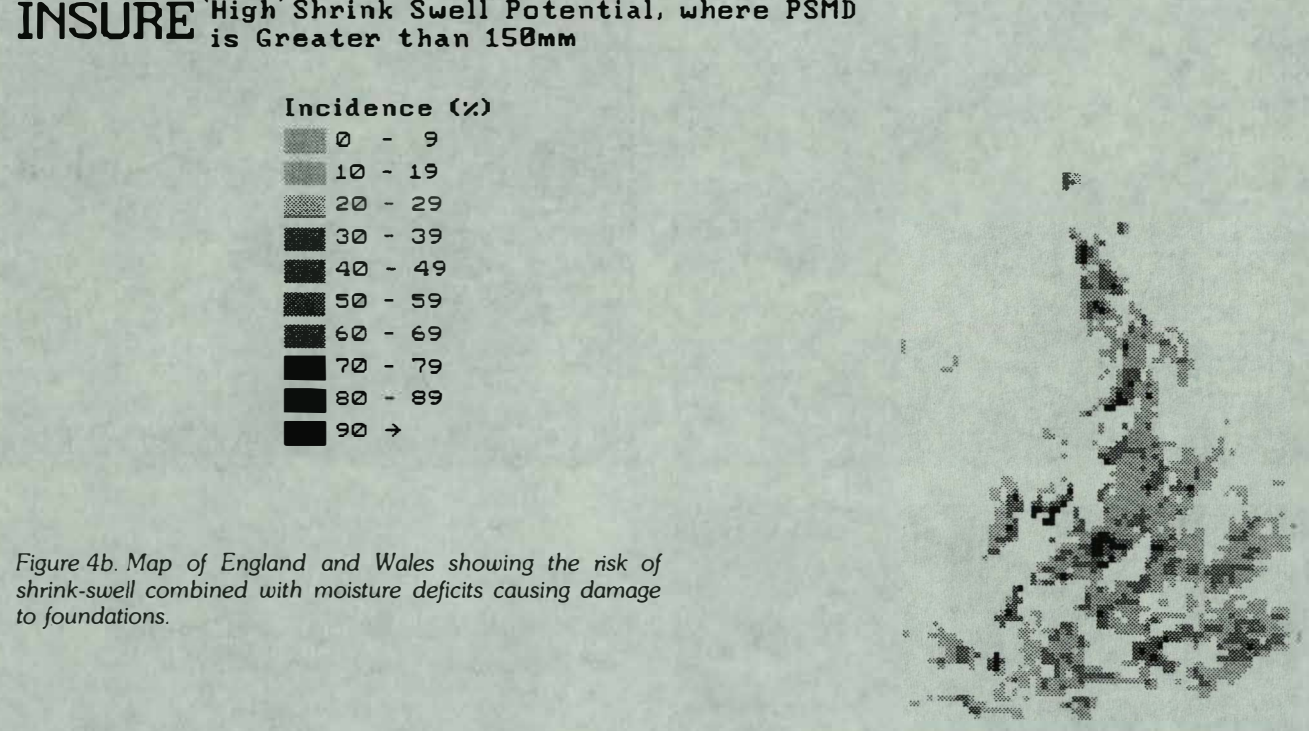


Figure 4b. Map of England and Wales showing the risk of shrink-swell combined with moisture deficits causing damage to foundations.

Figure 4a. Shrink swell potential of soils at 1–1.2 m depth from the Southampton survey-slide.

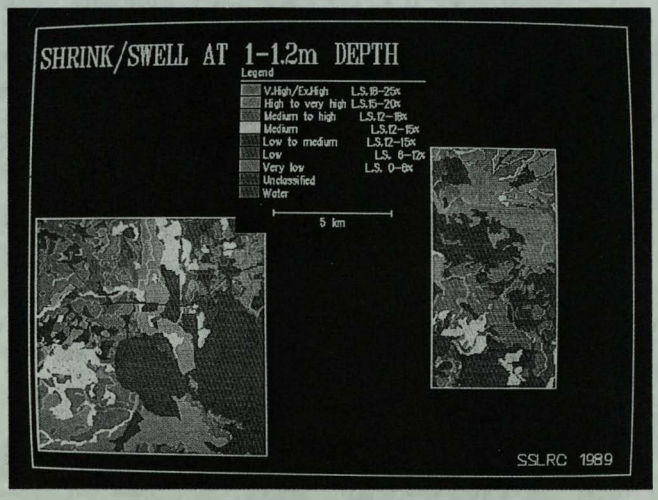


Figure 5. Slurry acceptance potential for South West England prepared for South West Water before the split into plc and NRA. Class III land is the land with most restrictions whether soil, climate, slope or hydrology.

and influences the likelihood of subsidence damage to buildings. Soil maps together with climatic data can be used to predict areas in which there is a risk of shrink-swell and where precautions need to be taken. For existing buildings the maps can show where the movement in foundations due to heave or to subsidence is likely.

Maps of the Southampton area have been produced using information from LandIS, digital map data captured in SPANS and bespoke software developed by SSLRC. The combination of these is called INSURE (Figure 4). Ovelaying postcode boundaries onto the INSURE database has enhanced its usefulness to clients using postcodes as their geo-referencing system.

The associated analytical data can also show where the material through which pipelines are laid is likely to be chemically aggressive causing serious corrosion of pipework.

Slurry acceptance potential

The combination of data from LandIS and digital map data captured in SPANS has been used to drive a model for slurry acceptance potential. Under a project funded by the South West region of the National Rivers Authority soil, hydrology, field capacity and slope data were transferred from the central LandIS databases, reclassified, modelled and combined with vector files of the coastline and river patterns. The output was a map differentiating areas suitable or unsuitable for the spreading of liquid animal waste (slurry) (Figure 5). The model provides South West NRA with a basis for implementing controls on the spreading of slurry and reducing the pollution of water courses.

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