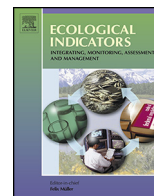




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Providing information on environmental change: Data management, discovery and access in the UK Environmental Change Network Data Centre

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ABSTRACT

Development of a clearer understanding of the causes and consequences of environmental change is an important issue globally. The consequent demand for objective, reliable and up-to-date environmental information has led to the establishment of long-term integrated environmental monitoring programmes, including the UK's Environmental Change Network (ECN). Databases form the core information resource for such programmes. The UK Environmental Change Network Data Centre manages data on behalf of ECN (as well as other related UK integrated environmental monitoring networks) and provides a robust and integrated system of information management. This paper describes how data are captured – through standardised protocols and data entry systems – as well more recent approaches such as wireless sensors. Data are managed centrally through a database and GIS. Quality control is built in at all levels of the system. Data are then made accessible through a variety of data access methods – through bespoke web interfaces, as well as third-party data portals. This paper describes the informatics approach of the ECN Data Centre which aims to develop a seamless system of data capture, management and data access interfaces to support research.

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1. Introduction

There is a growing need to improve scientific understanding of the causes and consequences of environmental change in order to inform mitigation and adaptation strategies. The routine collection of data from integrated environmental monitoring programmes can provide a wealth of scientific information and it is of prime importance that these data are made quickly available for research and policy decisions. To address this challenge within the UK, in 1992, the Environmental Change Network (ECN) was set up as the UK's long-term integrated environmental monitoring programme. It consists of 12 terrestrial and 45 freshwater sites throughout the UK, selected to cover the main range of environmental conditions present in the UK, where both biological and physical aspects of the environment are intensively monitored (Sier and Monteith, [this issue](#)). The monitoring programme covers a wide range of physical, chemical and biological 'driver' and 'response' variables, identified as being important for the assessment of environmental change. Measurements are made in close proximity at each site, using protocols incorporating standard quality control procedures

(Sykes and Lane, 1996; Sykes *et al.*, 1999); the protocols are also available online (<http://www.ecn.ac.uk/measurements>). The ECN programme is sponsored by a consortium of 14 UK Government departments and agencies (see acknowledgements) with an interest in the environment, who contribute to the programme through funding either site monitoring or network co-ordination activities.

Databases form the core information resource for long-term monitoring programmes such as ECN. Long-term environmental research databases must be reliable and stable in terms of data quality, secure over a long time span, accessible (but with access controls), and should facilitate spatio-temporal analyses of multiple variables at a range of scales. The use of reliable and well-supported database software is of paramount importance for long-term security; the ECN Data Centre uses the Oracle Relational Database Management System. When ECN was established in 1992, its sponsors agreed that a centrally managed database, with remote access links, was the model most appropriate to ensure a fully integrated system with the required data quality standards, i.e. those specified in the ECN protocols (Sykes and Lane, 1996; Sykes *et al.*, 1999). Today, the remit of the ECN Data Centre has expanded to include not only the management of ECN data, but also that of other related integrated environmental monitoring networks, including the Environmental Change Biodiversity Network (ECBN),

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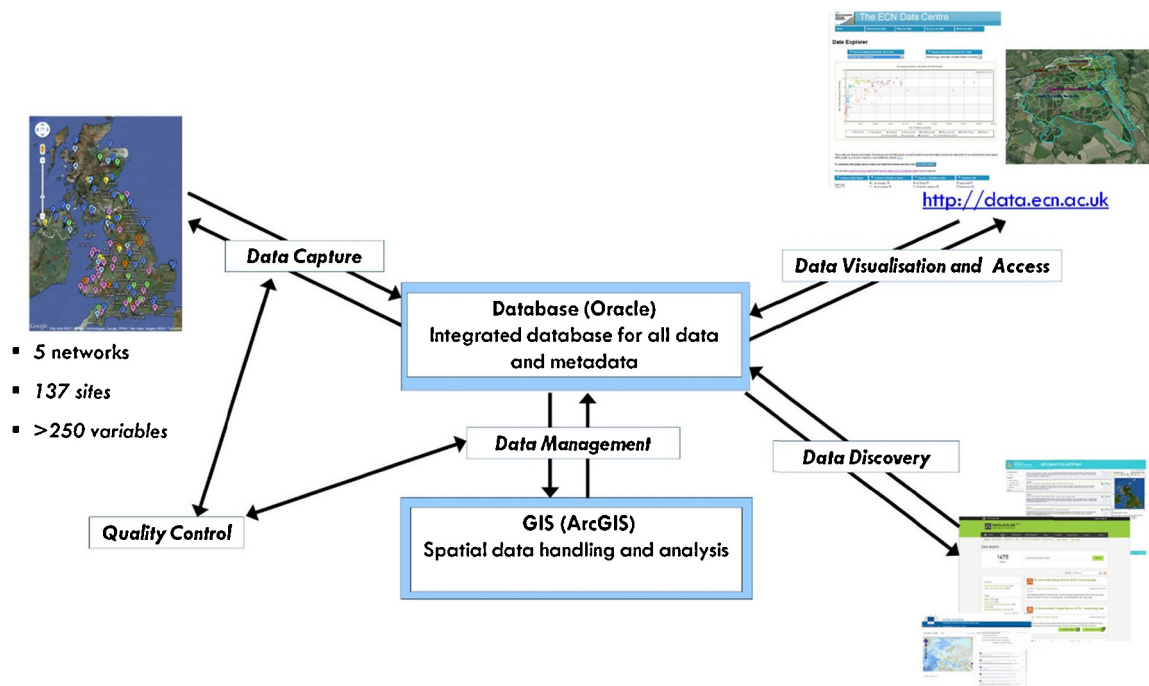


Fig. 1. Overview of the ECN Data Centre Information System.

the UK Lake Ecological Observatory Network (UKLEON) and the Upland Waters Monitoring Network (UWMN). The ECN Data Centre manages an integrated information resource (Fig. 1), storing all data and metadata collected at the 137 sites within these networks. Data from all networks are held in standardised structures in order to support the cross-disciplinary analyses necessary for environmental change research (documentation for these data structures is available online – <http://data.ecn.ac.uk/database-documentation/index.asp>). Data are regularly sent in from sites and are quality assured—before being lodged in the database.

One of the challenges facing managers of environmental databases is to provide data access mechanisms to suit the requirements of different users, who range from scientists and policy-makers, to students and the general public. These access methods should give sufficient guidance to users unfamiliar with the structure of the data (i.e. provide comprehensive metadata to ensure the data are understandable); whilst at the same time providing users with sufficient flexibility in data query and presentation. ECN was an early adopter of Internet-based data access (Brocklebank *et al.*, 1996, Rennie *et al.*, 2000) and it was one of the few direct data access portals available at that time. The ECN Data Centre continues to provide this access on the website (<http://data.ecn.ac.uk>) via a number of targeted data products.

ECN is the UK node in a global system of long-term, integrated environmental research networks and is a member of LTER-Europe (the European Long-Term Ecosystem Research Network – <http://www.lter-europe.net/>) and ILTER (International Long Term Ecological Research – <http://www.ilternet.edu/>). The ECN Data Centre provides information to both these networks and also provides metadata to a number of other national and international data portals to ensure the data are discoverable by users (see Section 4.3 for details).

This paper describes the informatics approach of the ECN Data Centre which aims to develop a seamless system of data, information and software tools to support research by taking a holistic view of programme requirements from data capture and management, through to data delivery and analysis. In so doing, it also complements the other papers in this special issue by providing

an insight into the origin and management of the datasets being discussed.

2. Data capture

At the start of ECN, working groups comprising scientists and statisticians representing a range of environmental disciplines agreed on a list of environmental variables to be monitored. Ever since, data collection and handling procedures have been co-ordinated and standardised across the sites through reference to published protocols (Sykes and Lane, 1996; Sykes *et al.*, 1999); which are also available online (<http://www.ecn.ac.uk/measurements>). These are designed to ensure consistency in measurement methods and data handling over time and across all of the sites. Data requirements are an integral part of these protocols and include specifications of variables, units, reporting precisions, dimensions, resolutions, reference systems and quality assurance procedures which have been used to design the database, construct standard formats for data transfer and standard field forms for each dataset. Wherever possible and appropriate, existing data capture techniques (e.g. Breeding Bird Survey (<http://www.bto.org/volunteer-surveys/bbs>), Rothamsted Light trap network (<http://www.rothamsted.ac.uk/insect-survey>), Butterfly Monitoring Scheme (<http://www.ukbms.org/>) and common coding schemes (e.g. Biological Records Centre (butterflies, carabid beetles, vegetation – <http://www.brc.ac.uk/>), British Trust for Ornithology (birds – <http://www.bto.org/>)) have been adopted to maintain ECN's comparability with other sectoral networks. These networks often have a narrower focus than ECN but a much wider geographical spread of sampling. In some circumstances, therefore, ECN can act as a 'bridge' to facilitate interoperability between these sectoral networks.

ECN, and the other contributory networks, collect a wide range of physical, chemical and biological measurements, using a variety of data collection methods, e.g. automatic loggers and surveying in the field by site managers. Data capture methods include manual recording (i.e. a site manager recording data in the field onto forms

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