Cranfield Environment and Agrifood

Centre for Environmental and Agricultural Informatics

Constructing a Digital Environment

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www.cranfield.ac.uk

Natural Environment Research Council

Pressing needs

Current environmental pressures and challenges, acute and long term, require **highly informed** decision making that is currently **not readily available** to decision makers.

Digitally connected communities and citizens expect **digitally enabled** engagement from policy and government across **all areas** of engagement, including the environment.

A rapidly developing field is including new ways of **observation**, **simulation** and **data infrastructure**, **distributed networks** of environmental **sensors**, additional forms of **autonomous** data collection, a **cyber-secure** infrastructure, and citizen-science.

The challenge..

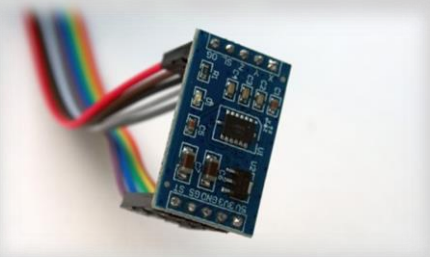
Advances in digital technology have led to a rapid **increase** in the **volume, velocity** and **variety** of data being captured, curated and managed on a daily basis.

Alongside this, new technologies have enabled a step-change in **global capacity** for integrated monitoring, analysis, modelling and visualisation of the Natural Environment at potentially **transformative spatial and temporal scales**.

This can be used more efficiently to inform **policy making** and to benefit **businesses, communities and individuals**.

The opportunity..

By harnessing these advances in technology and the UK's leading position in both **environmental**, **observational** and **computer/data sciences** there is an opportunity to create a **digitally enabled environment** through:



> more integrated networks of sensors (*in-situ*, proximal and remote sensing based),
> together with methodologies and tools for assessing, analysing, monitoring and forecasting the state of the natural environment
> at higher spatial resolutions and more frequently than previously possible

The Digital Revolution: The Economy 4.0

Economy 4.0: The next industrial revolution:

An array of different sets of technologies, which, when combined, generate genuine transformations in industry.

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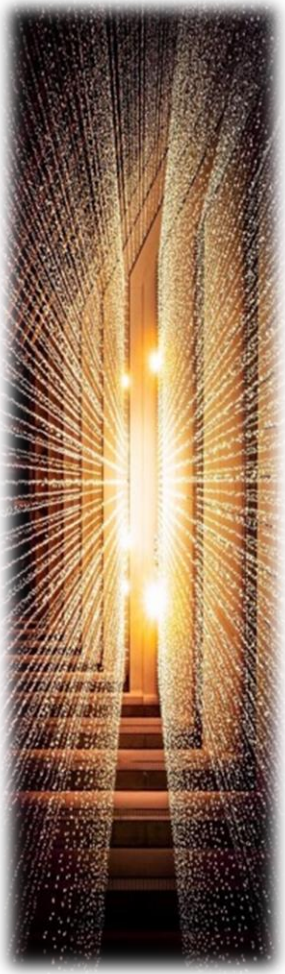
The Digital Revolution: The Economy 4.0

<u>The core offering is around connectivity…</u>

"Uber, the world's largest taxi company, owns no vehicles. Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world's largest accommodation provider, owns no real estate… " source: TechCunch

The Digital Revolution: The Economy 4.0



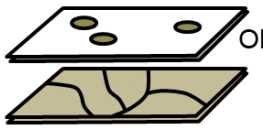
…..and deriving meaning from information, and information from data, and data from everywhere, all the time …..

As sensors and computational technology drop in price, everything, everywhere can be connected and computing will become ubiquitous.

…people, businesses, devices, and processes will be all connected seamlessly … paving the way for the ultimate lean enterprise. This will not be a nice-to-have differentiator, but an imperative for any ~~digital~~ business" source: Deliote

A new digital environmental science

Data identification

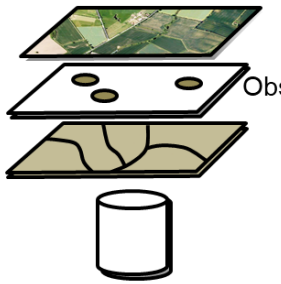


Direct data

Observational data

Thematic data

Examples:
Soil properties; soil mapping



Proxy data

Imagery data

Observational data

Thematic data

Statistical data

Examples: geology, weather, climate, topography, land cover, optical imagery, multispectral, NIR, electrical conductivity, agricultural census, CROME, agronomic records

Administrative data

Examples: RPA field boundaries, regions, catchments

Accessibility

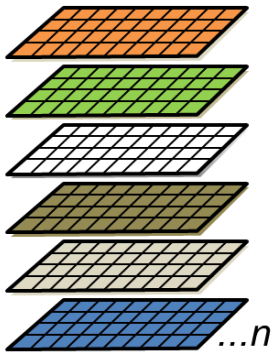
Examples: Open data, Proprietary data, licenced

Standardisation

Spatial harmonisation
Temporal harmonisation
Harmonised classification
Interoperability
Schema/Ontologies
Metadata

Pre-processing

Anomaly detection
Cluster analysis / PCA
Descriptive statistics
Identify data gaps



Policy drivers

Examples: 25Y Env Plan; Green Brexit; Env Act Wales, Natural Resources Policy

Policy questions

Digital expression

Coding policy question to target variable/s
Stratification

Machine learning

Bayesian network
Decision trees
Multivariate adaptive Regression splines
Artificial neural network

Results

Expression of policy question
Model performance statistics
Confidence

NERC-led Wave 1 SPF investments

Constructing a Digital Environment
Focus: To apply the latest technologies to environmental data from sensor networks across the UK, in order to deliver information in unprecedented detail. This will enable the construction of an integrated, digital picture of our natural environment, bringing benefit to policy-makers and other users.

Clean Air: Analysis and Solutions
Focus: to predict future air quality challenges, identify the most vulnerable groups in society, improve new technologies and policies for reducing air pollution, and create a system for providing robust consistent advice to decision makers.

UK Climate Resilience
Focus: to harness multidisciplinary expertise to deliver robust climate risk and solutions research, which ensures the UK is resilient to climate variability and change, and powerfully positioned to exploit the opportunities of adaptation and green growth

Landscape decisions
Focus: to develop a new understanding to help individuals, communities and country make the best choices regarding land use in the UK.

Digital Environment elements

Acquisition of data

The ability to acquire unprecedented amounts of environmental data – utilising technologies such as remote sensing, Internet of Things, citizen science and data mining

Storage and processing of big data

The ability to store and process big data through the unprecedented and elastic/on demand resources offered by cloud computing (cf. the age of *exascale* computing)

Data Science and AI

The ability to make sense of this big data through breakthroughs in data science and Artificial Intelligence (AI)

Visualisation, Decision-support

The ability to visualise, present and interact with this data and its subsequent analyses to support communication to different stakeholder groups, and hence support decision-making.

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Digital Agriculture : The Digital Revolution meets growing life

There are broadly 3 business models currently realizable in the Digital Agriculture

1. The digital twin model: *integrated farm care business*

   Here the digital solution aims at creating a whole farm systems model encompassing environmental, management, operational and business aspects of the farming operation.

2. The big data model: *creating business opportunity from crowd sourcing*

   Here the digital solution supplies a cross sectorial product aimed at maximizing participatory uptake and obtaining value from this.

3. The AI model: *the business of prevent and cure*

   Here the digital solution supplies a cross sectorial product aimed at maximizing business intelligence from proprietary data to generate business opportunity for specialist suppliers.

Digital Agriculture: The Digital Revolution meets growing life

The digital twin model: *integrated farm care business*

- The business push is around:

i. New markets for existing digital players, particularly business platform builders – but also other disruptive digital emergers.
ii. Upselling capital intensive equipment.

- The business pull is around:

i. Leaner farming systems.
ii. Better price point for produce.
iii. Acquiring whole businesses intelligence for growers .

- Characteristics of this model:

i. Tends to depend on IoT solutions.
ii. Digital interface with grower is key.
iii. Relatively high initial outlay.
iv. Farm business specific (bespoke user model).

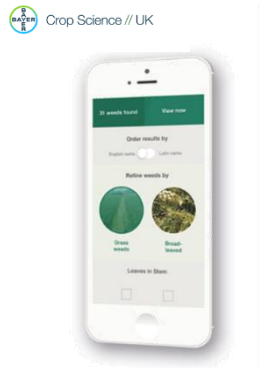
Digital Agriculture: The Digital Revolution meets growing life

The big data model: *creating business opportunity from crowd sourcing*

- The business push is around:

i. New markets for novel digital players, particularly SME platform builders.

ii. Increasing market share for existing suppliers of farm inputs (e.g. fertilizers, plant protection products) through market captivation.



- The business pull is around:

i. Ease of acquiring agri-business intelligence for growers.

- Characteristics of this model:

i. Cross sectorial offering.

ii. Low barriers for user uptake, seeking to maximize the number of users.

iii. Upselling or cross selling through digital platforms.

iv. Effortless digital platforms.

Digital Agriculture: The Digital Revolution meets growing life

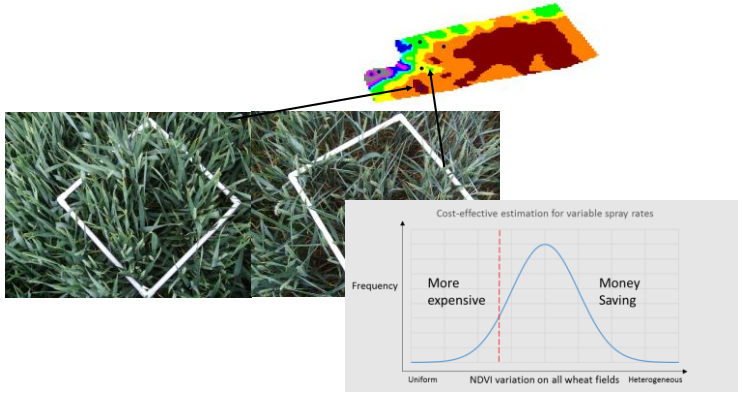
The AI model: *the business of prevent and cure*

- The business push is around:

i. Maximising business opportunity and increasing market share through market intelligence

- The business pull is around:

i. Maximising business output (e.g. yield)
ii. Reducing farm inputs



- Characteristics of this model:

i. New offering by existing agribusinesses.
ii. Obtaining new information from existing data spanning grower businesses combined with external (publicly) available data sets e.g. benchmarking, derisking, predictive disease control.
iii. Digital platforms mainly exist with the supplier base, but are increasingly shared with growers, ensuring market share.

Digital Agriculture: The Digital Revolution meets growing life

The Promise

More efficient, better quality farms

More effective food chain systems, less food waste

Better control, more resilient raw material food supply systems

Less impact on the environment

More intense farming/more land for other uses

Better livelihoods for farmers, from small to large

The Risk

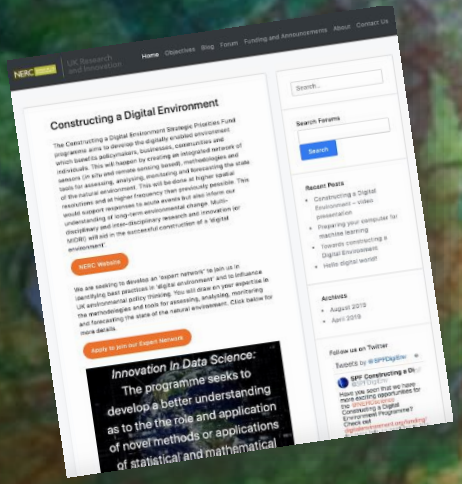
Loss of control/competitive advantage

Tighter regulation

Ownership of data and IP

Loss of traditional farming methods & expertise

Reliance on technology



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