Environmental Data Management:

CHALLENGES AND OPPORTUNITIES

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SRA Information Technology

If the data you need still exists;
If you found the data you need;
If you understand the data you found;
If you trust the data you understand;
If you can use the data you trust;
Someone did a good job of data management.

Rex Sanders - USGS-Santa Cruz

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Jamie Gerrard | March 2014

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About the Author

Jamie Gerrard is a Senior Environmental Consultant with SRA Information Technology. Jamie developed an appreciation for good data management practices early in his career while working for Hill 50 Gold, where he spent many days searching waste dump faces for pit trap locations with a metal detector. This was required to replicate a fauna monitoring program where, luckily, the fly wire was detectable, but accurate recording of coordinates and projection in the first instance would have been preferred.

Ensuring data capture will enable effective knowledge development and decision making has been a constant theme in Jamie's twenty year career within mining and consulting businesses.

Environmental Data

All developments, land-based or sea-faring, have the potential to impact other users of the area. They can also affect multiple environmental aspects such as water; air; flora and fauna; and community and cultural values.

During the course of a normal day an environmental management professional often deals with numerous types of data that are collected, analysed, aggregated and utilised for many different purposes. At the same time, a range of collection methods and scientific disciplines can be utilised to collect this data. Adding to this complexity, the types of data range from quantitative to qualitative.

For example, collection of fuel consumption records from machinery is required for financial accounting, but is also used for emissions reporting. Geological information collected during mineral resource drilling is required to define the dimensions of the ore body to be mined, but is also critical for determining waste management options and potential for acid mine drainage. Planning a road requires knowledge of the ecology to be disturbed, archaeological and anthropological sites of significance, surface water drainage and soil composition.

Traditionally, environmental monitoring was often reactionary as regulatory agencies defined monitoring requirements and associated compliance limits.

It is also becoming increasingly necessary to access data from multiple domains (soil, geology, groundwater, water quality, biology etc.) to carry out 'big science'. For example, the impact of Coal Seam Gas on aquifers, ecosystems,… etc. This requires access, by non-experts in those domains, to data presented in formats that can be understood irrespective of domain speciality.

Traditionally, environmental monitoring was often reactionary as regulatory agencies defined monitoring requirements and associated compliance limits. This type of monitoring was viewed as an operational cost, with little further financial value. This monitoring was often conducted due to a licence requirement rather than as a means of testing business policies and ensuring objectives were achieved.

More recently, intelligent management of environmental monitoring data has been recognised as a vital tool for decision makers in:

- Recognising, minimising and mitigating risk;
- Maintaining social license to operate; and
- Ultimately, providing a tangible return on investment.

Regulators are also moving away from dictating compliance limits, toward an approval setting. Project proponents are increasingly expected to demonstrate that risks have been assessed, mitigation plans are in place and monitoring plans have been submitted for approval. The requirement to demonstrate completion of environmental remediation programs is also becoming more risk focused, which brings increasing scrutiny of the data used to demonstrate compliance with completion objectives.

Challenges with Environmental data

The enormous diversity in the types of data used for assessment and indicating environmental change requires input from experts across many scientific disciplines in developing and analysing monitoring programs.

Quantitative data, such as water levels and chemistry, has well-established QAQC procedures using known standards, sample duplicates and sampling and analysis protocols, which builds confidence..

If we consider an example of semi-quantitative data, such as flora diversity, there are different measurement methodologies, taxonomical name changes often occur, observer experience is a greater factor and statistical analysis may be applied to provide a meaningful result. This requires different approaches to ensure the supporting information required for data confidence is appropriately captured and assessed.

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There is also a great deal of qualitative information captured in the course of environmental monitoring. Incident reporting and investigation are examples where many pieces of information may be collected from differing and diverse observers, along with the many types of evidence that need to be collated. Traditionally its collection has been for storage and reporting, however there is now the challenge to better utilise data for future prevention.

Technological changes in the environmental field are occurring faster than ever before, with remote sensing and aerial photography data becoming more accurate, significantly less expensive and more readily available. The ability to process and interrogate using change detection tools is also generating both spatial and temporal data, requiring new management approaches.

The availability and range of real-time data is also growing, presenting new challenges, especially in regard to how real-time quality control and interpretation can be achieved. Provision of real time data to relevant decision makers and consumers needs to be considered in context: delivery; relationships with other data types and feeds; and provenance of the data may be significant to interpretation.

There is a growing requirement to enable multiple data types to be automatically and concurrently analysed. An example is dust monitoring, where real-time wind direction and dust concentration needs to be compared in order to trigger meaningful alerts to an operator.

Automation and Accessibility

There are a number benefits to automation such as reduction of manual handling errors and decreases in processing time delivering potential cost savings.

Government, business and community bodies increasingly expect data flow to be both automatic and reliable. There are a number benefits to automation including a reduction in manual handling errors and a decrease in processing time, delivering potential cost savings. Automation can also increase user understanding, as the data delivered is often more explicit and ensures data currency and reliable provenance. In order to achieve this, it is critical that data flow is clearly mapped, potential failures are identified and management mitigation measures are understood and actioned.

When monitoring and/or analysis is conducted in areas where telemetry is of limited coverage or quality, it creates significant complications to data transfer and synchronisation. There is growing expectation that data visualisation can be achieved via multiple methods, using devices and web browsers.

Achieving consistent accurate data transfer from field collection through to analysis ultimately involves many complexities, which is the major driver of systemisation of data management processes.

Standardisation and Accounting

Recently there has been movement toward the greater standardisation with regard to the management and transfer of raw data.

In order to share data and compare results, standards for consistent measurement and reporting are vital. They facilitate performance comparisons of different organisations and companies.

Since the late 1990's, a number of initiatives have been implemented to facilitate this process. Examples of environmental accounting and reporting guidelines include, but are not limited to:

- System for Environmental Accounting (1993)
- Global Reporting Initiative – (1997) currently 5,971 global organisations complete sustainability reports using this initiative
- National Pollution Inventory Reporting
- NGER (Australia), API (US), ISO 14064 GHG Emissions Inventories
- Australian Water Accounting Standard (2014)

The discipline of environmental accounting is a burgeoning field and associated existing reporting guidelines generally focus on data that has been aggregated to an organisational level. Recently, there has been movement toward the greater standardisation of the management, transfer and interpretation of raw data.

During 2007, in response to nationwide water restrictions, the Australian Government mandated the Bureau of Meteorology (BoM) to develop and maintain a National Water Information System. In order to facilitate this, the BoM established the Water Data Transfer Format (WDTF) to enable major water providers to submit data. This work has been progressed to harmonise with a model developed by the Consortium of Universities for the Advancement of Hydrological Sciences (CUAHSI) WaterML. The resulting Water ML2.01 is now an Open Geographic Consortium (OGC), it is expected that this will be progressed to an international standard through International Standards Organisation (ISO).

The US EPA has progressed further, with regard to standardisation of environmental data, releasing 27 standards since 2006. These standards are aimed at facilitating the transfer of data between itself,the States and Tribal lands in the United States. These standards cover a broad spectrum of data types and enforce standard terminology and minimum metadata inclusions.

Directive 2007/2/EC of the European Parliament and the Council was enacted in 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). The directive addresses 34 spatial data themes required for environmental applications and has legally mandated that member countries must deliver data using OGC standards.

Both the developing Australian Water Data standard and US EPA standards are progressing toward consistency with the standard for Observations and Measurements, which was first proposed by OGC and has since been implemented as ISO19156 – Observations and Measurements. The pathway to standardising monitoring standards through the OGC is being embraced by governments and independent organisations, globally.

The main causes of environmental data waste are: inappropriate organisation and storage; lack of critical metadata; and changes in monitoring processes which prevent monitoring results to be meaningfully evaluated over time. Increased standardisation will increasingly assist in minimising these issues.

The ISO14000 series of standards for Environmental Management provides a good framework for a structured and organised approach to environmental management and continuous improvement. Management systems established to comply with this and similar series', such as ISO 9000 and 12000, generally document processes that need to be completed and specify how information is to be assessed to ensure continuous improvement.

ISO19156 Geodetic Information - Observations and Measurements provides a framework that ensures consistent data structure and metadata details for any time series data to be managed in a consistent and transferable manner. The array of recognised monitoring standards commencing with water data is anticipated to be formalised incoming years.

Why has standardisation of environmental data lagged?

Interestingly, the development of National standards for data transfer, in regards to geological data were initiated ten years before those for water. The Australian Requirements for the Submission of Digital Exploration Data are the result of collaboration between the Federal Government and the state and territory governments. These Standards have been instrumental in ensuring data management and transfer consistency within this discipline.

The reason is simply economic; geological data is an asset, as well as a critical component to the development of mineral resources. As Governments have an interest in seeing mines develop, there has always been a tangible return on investment (ROI) in regard to managing and storing this data.

It is also a data type that could have a significant bearing on company share prices and has been compromised in the past to inflate share prices. The most famous of these was the Bre-X scandal in Canada; in the late 1990's, gold was added to samples prior to analysis, sending the company value from near nothing to $6 Billion prior to its collapse on discovery of the fraud. This scandal was a major impetus for many countries to introduce codes of practice, such as Australia's JORC and Canada's NI41. These codes define requirements for mineral resource estimations released to stock exchanges. They focus on ensuring interpretation is reasonable and based on sound and defensible foundations, rather than standard formats at the individual measurement level.

It is important that data collected today will be able to be located and used with confidence in the future.

While these codes of practice are fairly consistent, Canada's NI41 is the most advanced, including significant detail on the management of data, as well as a requirement for independent verification of resource statements. Results are seen as worthless without the associated sampling and analysis methodology, Chain of Custody details, Quality Control and Quality Assurance (QAQC).

It is important that data collected today will be able to be located and used with confidence in the future. It is estimated that globally, 700,000 items of data are lost every day, for reasons such as ink fading through to hard drive failure. The development and application of ISO standards for aspects of data management provides confidence that data will remain accessible and useful.

Interoperability

The submission of raw data to regulatory agencies has, for many years, been a standard requirement for environmental reports. Traditionally, the supply of raw data was as an environmental report attachment or appendix. It is evident that we are now moving into an era where all data will be expected to be electronically transferrable: from system to system; between organisations; and from the private sector to regulatory agencies. It is anticipated that the introduction of this transferability, by the US EPA and European INSPIRE directive, will gradually be replicated by other countries and environmental agencies.

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While there will always be value in the maintenance of a secure, reliable and auditable data repository, decision makers are increasingly demanding data is delivered in a manner providing a holistic view of an organisation's environmental status, at any given point in time. In order to achieve this, the interrogation of large, diverse and complex data sets is required, as is a system that delivers:

- Confidence in the accuracy and reliability of the data
- Understanding of the consequence of the data
- Recognition that not all data streams are equal
- Awareness that data streams need to be treated appropriately
- An indication of the completeness of the dataset required to perform the necessary analysis
- Measured compliance of results with respect to targets, from which performance can be assessed against business objectives and management actions can be prioritised and implemented

The growing realisation that there can be significant operational benefit from incorporating environmental data into daily planning has seen a growing demand for:

- Forecasting and Data Projection
- Multi Criteria Analysis
- Predictive Analysis and Scenario Modeling
- Dynamic Risk Assessment and Management

Public Disclosure

There is also a realisation by governments (who hold much of the economic, land use and scientific data) that accessibility is vital in assisting innovation and economic development.

Growth of the internet and digital communication devices has initiated a trend by government and private organisations in Australia to provide data to the community. There are many drivers for this including investment attraction, public transparency, encouragement of innovation, brand recognition and protection, and community engagement.

Public disclosure of environmental performance is becoming more important for resource companies in gaining and maintaining their licence to operate. The Port Hedland Industry Council is an excellent example of how resource companies such as BHP Billiton, Rio Tinto and others can combine resources to provide the Port Hedland community with real-time, air quality data in an understandable format. The Upper Hunter air quality monitoring network in New South Wales is another example of real-time, environmental data delivery.

Governments (who hold much of the economic, land use and scientific data) have realised that accessibility is vital in assisting innovation and economic development. Consequently, there are programs across Australia to deliver geospatial data via OGC web map and web feature services, as well as downloadable data sets. Value creation is also being encouraged through the movement toward creative commons licencing of government data.

Conclusion

It is well recognised that environmental data must be complete, reliable, defensible and retrievable.

As communities and investors place greater value on social and environmental responsibility, resource companies are realising their social licence to operate can no longer be taken for granted. The number of cases where resource companies have been denied approval to develop and/or suffered penalties for environmental failures is growing.

It is well recognised that environmental data must include provenance, be complete, reliable, defensible and retrievable.

There is now growing appreciation that environmental data is an asset of significant value that requires active management to preserve and effectively utilise. The ability to efficiently process and incorporate environmental data flows into risk models will benefit organisations by enabling rapid issue identification and response. The earlier a potential issue is identified, the greater the ability of decision makers to prevent or mitigate its impact.

The growth in popularity of geospatial information and the internet provides both opportunities and challenges for community engagement, regulatory reporting and public transparency. This has initiated a global push to standardise environmental data management and transfer through the OGC and ISO. There are also developments in areas of the Semantic Web and Linked Data initiatives, which will need to be followed and considered in the future.

Selected Useful Website Links

Australian Institute of Environmental accounting
http://environmentalaccounting.org.au/

Australian Requirements for the Submission of Digital Exploration Data
http://www.geoscience.gov.au/National_Guidelines_Version_4_2_Aug_13.pdf

Bre-X scandal as reported by the Washington Post
http://www.washingtonpost.com/wp-srv/inatl/longterm/canada/stories/brex051897.htm

Bureau of Meteorology (Australia) Water data transfer format
http://www.bom.gov.au/water/standards/wdtf/

Environmental Data Standards – US EPA
http://www.epa.gov/fem/data_standards.htm

European Commission – INSPIRE Directive http://inspire.ec.europa.eu/

Global Reporting Initiate https://www.globalreporting.org/Pages/default.aspx

Hunter Valley Air Quality Network – New South Wales EPA
http://www.environment.nsw.gov.au/aqms/uhunteraqmap.htm

International Standards Organisation (ISO) http://www.iso.org/iso/home.html

Joint Ore Reserves Committee (JORC) – Australia
http://www.jorc.org/index.asp

National Greenhouse and Energy Reporting
http://www.climatechange.gov.au/climate-change/greenhouse-gas-measurement/national-greenhouse-and-energy-reporting

National Instrument 41 – Canada
http://www.osc.gov.on.ca/en/SecuritiesLaw_rule_20131017_52-108_pro-repeal-replacement.htm

Open Geospatial Consortium (OGC) http://www.opengeospatial.org/standards

Port Hedland Industry Council – Western Australia
http://phicmonitoring.com.au/rt/realtime.jsp?siteId=371

SRA Information Technology http://www.sra.com.au/

The Semantics Web http://linkeddata.org/

The Linked Data Initiatives http://linkeddata.org/

World Bank Environmental Accounting
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/0,,contentMDK:23140072~pagePK:148956~piPK:216618~theSitePK:244381,00.html