EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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BRO: establishment of a national register and database for subsurface data in the Netherlands – lessons learnt

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STSM Report to COST MC Chair

TNO innovation for life

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Contents

1. STSM rationale

The establishment of national register for all subsurface data (BRO) within the Netherlands by TNO is a hugely significant body of work and forms a benchmark case study to the COST subsurface action in data management and use.

Increased standardisation of subsurface data is required in nearly all COST cities and countries to increase the accessibility and re-use of subsurface data, and to maximise the collective potential value and past investment in these data. The urban subsurface is being increasingly utilised for infrastructure as well as energy and water abstraction, and there is growing recognition of the need for urban planning to be three-dimensional with guidelines for the subsurface. In tandem with this, uncertainty in ground conditions due to limited accessibility of ground information, remains one of the biggest sources of project overspends to the construction industry and overly conservative design in many countries. Poor data accessibility is also a significant constraint to development of 3Dsubsurface models to improve site investigation design and inform urban development.

This STSM will allow knowledge exchange between key personnel in BGS and TNO to evaluate the key lessons learnt from the implementation of BRO, and their applicability to other countries to achieve increased standardisation of data and better data capture. The discussions and lessons learnt from implementing BRO in the Netherlands are directly relevant to the current GSPEC pilot by the BGS in the UK to try and enforce submission of all subsurface data to a national BGS data repository, using a standardised digital data formatting format, to improve subsurface data accessibility and re-use in the UK. The STSM outputs will also be of immediate benefit to the Working Group 2 sub-group reviewing and identifying best practice in subsurface data management across Europe, but the evaluations and outputs of the STSM are highly relevant to the wider COST SUBURBAN Action as a whole.

2. Work carried out within the STSM

The STSM involved a 5 day visit of the STSM applicant (Helen Bonsor [BGS]) to TNO in Utrecht, 23 to 27 February 2015. The STSM discussions were centred on:

- Antecedent conditions which enabled subsurface data to be included within national legislation and the development of a national subsurface data register and database
- The work and issues to invoke a change in national legislation
- Implementation of BRO from preceding DINO-lokot data registration system in Netherlands – a switch from contractual to leglislative driver for data submission
- Adminstrating BRO – the challenges and opportunities
- Altered expectations of private sector to TNO data products and services
- The cost benefit analysis of BRO to TNO and Netherlands

Meeting were led by a series of different specialists within TNO:

- **Michiel J van der Meulen** – antecedent conditions to BRO
- **Ronald Vernes** - 3D geological and hydrogeological mapping in Netherlands.
- **Wim van Berkel** – developing the database architecture and systems to implement BRO
- **Stephan Gruijters** – Implementation of BRO from preceding DINO-lokot data registration system
- **Jan Stafleu** – Development of 3D subsurface models from TNO data - GeoTOP

3. BRO: establishment of a national register for subsurface data in the Netherlands

3.1 The BRO concept

There is growing recognition of the need to include the subsurface explicitly within urban planning processes. To achieve this there is demand for geological surveys to be able to develop more robust 3D subsurface models to assist sustainable management of cities and support decision making. This, ultimately, requires geological surveys to be able to access a larger amount of subsurface data – particularly that which is generated within the shallow surface by the professional community (consultancies and contractors) and not typically required to be reported to governments or geological surveys in Europe.

To achieve better data capture – indeed comprehensive data capture – the geological survey of Netherlands (TNO) and the Dutch Government have written new legislation which will require all subsurface data generated in the Netherlands to be submitted to a national key register of subsurface data ('BRO') which will be managed by TNO. To manage and maintain this volume of data, from such a wide range of data sources, relies on automated ingestion of standardised subsurface data.

Implementing automated ingestion of standardised digital subsurface data represents, and has, instigated more than a change in data management within TNO – it will transform the way in which the survey can use data, the way the survey delivers data (through web services, 3D and 4D models) and the role of the survey to the professional user community (data provider, and less so provider of data products). Data intake and data delivery will be facilitated by automated web services. The accuracy of data will not no longer be manually processed and validated by the survey – only the completeness and format of intake data.

3.2 Favourable antecedent conditions to implementing legislative change

There were multiple favourable antecedent conditions which acted as levers for this step-change to happen. Each of the background drivers required access to larger standardised subsurface data which could be rapidly processed, accessed and re-used – above that already provided by DINO and DINO-loket.

Existing legislative framework

Prior to BRO, only deep (>30 m deep) subsurface data were legally required to be reported to the geological survey, under the Mining Act and Dutch Water law. Shallow subsurface data (<30 m deep) were deposited to TNO under a voluntary basis, and with no legal or contractual requirement of compliance to a prescribed data standard, or data reporting format. As a result, a mixture of PDF information and digital borehole data were supplied to TNO by the private sector, and a significant proportion of shallow borehole data (<10 m deep) were not supplied to TNO at all in the absence of a legislative or contractual requirement to do so.

Existing data management

DINO

Prior to BRO TNO managed DINO – the Dutch national subsurface database (***D**ata en **I**nformatie van de **N**ederlandse **O**nderground*). DINO was developed in 2000 by TNO, primarily for use by TNO (the geological survey), to amalgamate the different subsurface datasets previously held by the State Geological Survey and TNO before they merged in 1997 to form TNO in its present form. Prior to this merge, the former TNO was custodian of groundwater data, and the State Geological Survey, survey borehole data and the digital E&P archive.

Having a national subsurface data archive, albeit non-comprehensive and non-standardised, enabled TNO to make a strong case to the Dutch Government to the value of having a national key register for subsurface data: DINO had enabled the geological survey to move from 2D to 3D national modelling; it had increased re-access and re-use of the subsurface data, not only by the survey internally, but by outside stakeholders through a range of web portal services. The DINO database holds hundreds of thousands of boreholes and cone penetration test (CPT) data points, and hundreds of millions of groundwater-levels, amongst other data sets.

Incorporating subsurface data into a *key register* would take things one step further – including subsurface data within national legislation would mean all subsurface data would be captured, and it would be to a validated national standard – increasing the transferability and usability of data.

Web portal services and existing data access

A large amount of subsurface data was already freely available from DINO to external stakeholders and the general public, from the DINO user interface 'DINO-loket' (www.dinoloket.nl) – Fig. 1. DINO-loket comprises a web portal service in which users could request subsurface data and information in a range of formats fit to their purpose – e.g. 2D maps, 3D models, PDF lithological logs, tabular groundwater-level data. DINO-loket has around 6000 registered users, from individual to institutional licensees.

Based on these existing data services and products, the Dutch government and other key users of subsurface data (i.e. consultancies, contractors) could already see the value in developing DINO to a key register, and thereby having a larger, standardised, comprehensive subsurface database, from which more data outputs could be more rapidly updated, as well as being based on a higher density of input data.

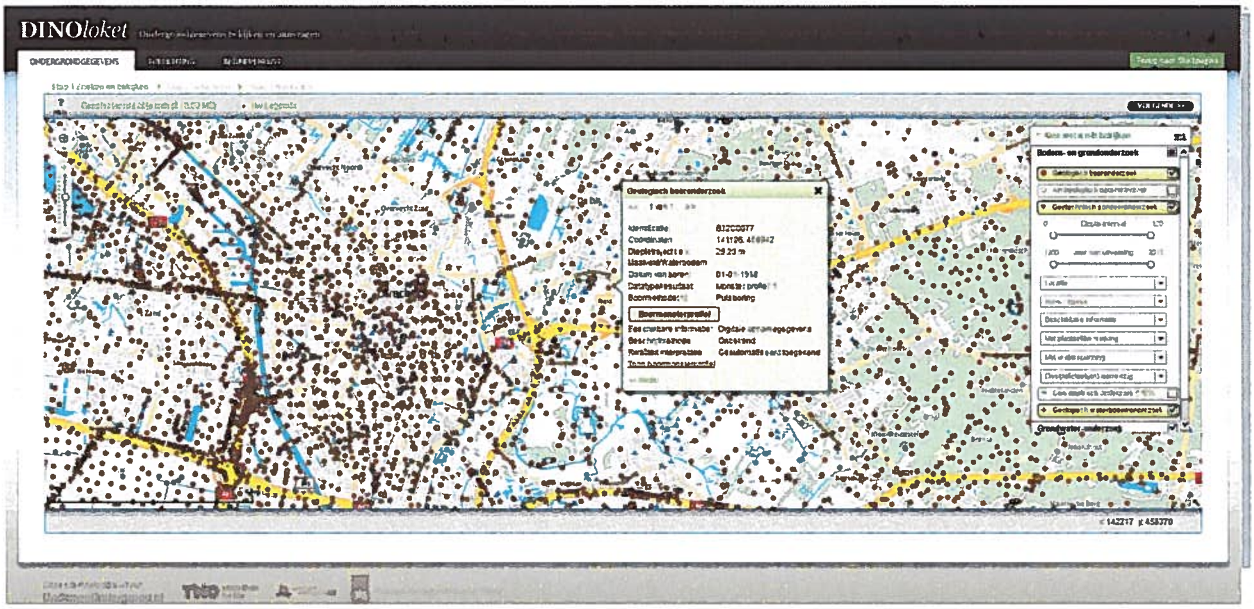

Fig. 1 A wide range of borehole data is accessible from the DINO web portal interface 'DINO-loket'.

Move from 2D mapping to 3D national modelling

2D mapping and the national 1:50K and 1:250K mapping programmes were discontinued by TNO in the late 1990s– primarily due to time and cost, and also the application possibilities were considered to be limited (van der Muelen et al. 2013). This represented a shift from understanding and representing geological information in maps, to using the information to predict the distribution of different properties of the subsurface.

National 3D modelling demands a large amount of standardised digital subsurface data, which can be rapidly processed and input to different models. This was another favourable boundary condition for negotiating a change in legislation to better capture subsurface data in the Netherlands.

Move towards an 'e-Government'

Concurrent with the move towards increasing demand for quantitative 3D and 4D modelling, the Dutch Government is moving for increased digital data ingestion to achieve an 'e-Government'. As such, having a key register for subsurface data, which would be received and stored as standardised digital data was desirable to the Dutch government.

Acknowledgement of need for subsurface planning

The subsurface within the Netherlands is utilised for gas extraction, public water supply, shallow and deep geothermal energy, and mineral exploration in the Netherlands. As a result of the increasing use of the subsurface, and recognition of the potential economic cost of mis-management of the subsurface, planning within the Netherlands underwent a fundamental shift in the early 2000s to explicitly include the subsurface. Planning is now based on a 'layer approach' containing three distinct layers: – the occupation layer; network layer; and the subsurface layer. Each layer requires distinct planning, but also consideration of the other layers. The layers are defined on the basis of the different rates of change of infrastructure within each – Fig. 2. This fundamental change to 3D planning in the Netherlands formed a key driver for the need for a subsurface key register within the government.

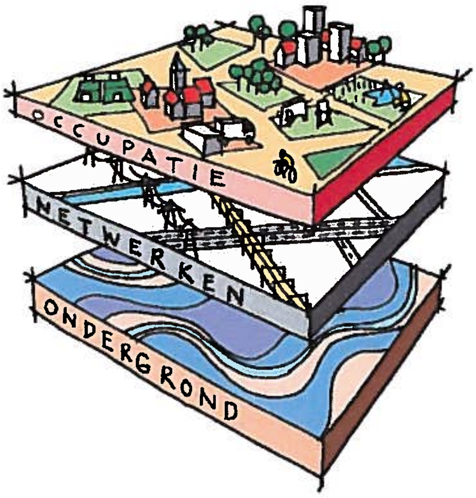

Fig. 2 – the layered planning concept developed in the early 2000s within the Netherlands.

Relationship between the Dutch Government and Geological Survey (TNO)

The current Geological Survey of the Netherlands is the result of a number of reorganisations. In its present form the geological survey (TNO) is almost exclusively focused on gathering, interpreting and delivering subsurface information. It has a direct mandate in supplying geological advice to the Ministry of Economic Affairs, the Ministry of Infrastructure and the Environment, and it has entry points at all levels of the ministry hierarchy, from Director Generals, to the Secretary General and Ministers. This enabled TNO to have a very strong voice in advocating and communicating the need for a key register for subsurface data, and to push for the legislative change to realise this.

3.3 Achieving legislative change

Multiple favourable antecedent conditions acted as levers for change to national legislation to develop a 'key register' of subsurface data. Each of the background drivers required access to larger standardised subsurface data which could be rapidly processed, accessed and re-used – above that already provided by DINO and DINO-loket. Recognition of this by the geological survey, and their strong advocation for change, via the direct access to ministers within the government, was pivotal to the change in legislation happening.

The process has taken a significant investment and effort by TNO, but comparative to the rate of legislation change in the UK and elsewhere, the change has happened relatively quickly (mostly within 4 years). The law has now been agreed in principle between TNO and the Dutch government, and is waiting to be passed by parliament (August 2015) and the King, after which the law will become effective.

Stakeholder engagement and response

Stakeholders and private sector organisations became involved in the consultation process after the need for legislative change had been agreed in principle between TNO and the Dutch government.

The initial reaction of local government and key private sector organisations to a key register of subsurface data was mixed. Local government and city municipalities feared it would add to their administration burden, which has increased significantly in recent years concurrent with budget cuts under the political right coalition government. The major consultancies and contractors saw the change in legislation as a loss of revenue stream – as in the future, all shallow borehole data will be freely and publically available from the centralised BRO database. Previously, consultancies held their own significant shallow borehole datasets, to which access was sold for a fee.

3.4 Work to implement a national key register of subsurface data (BRO)

Implementing a key register of all subsurface data has required a large amount of work by TNO. It will change, fundamentally, the way in which the survey receives and intakes subsurface data. In the past, data received by the survey has been manually handled by the survey staff before being entered in the DINO database and a range of digital and non-digital (PDF) formats were handled. Under BRO, a much larger volume of subsurface data will be deposited to the survey, with it being a legal requisite to deposit shallow, as well as deep, subsurface information to the survey. Processing such large volumes of data cannot be done manually, and BRO relies of automated ingestion of standardised data by the survey. Unlike DINO, the BRO database will be populated by direct input from third parties (e.g. consultancies and contractors) without intervention by the survey.

TNO has had to develop, trial, and communicate, new technical data standards, and a standardised digital reporting format with outside third parties.

BRO represents a fundamental change to DINO and step change to current subsurface data management by the survey

The BRO database is fundamentally different to DINO: DINO was developed and designed by the survey for the purposes of the survey; the BRO database, as a national register, has a much broader mandate, and end users, and the design of BRO and the format of data inputs and outputs, was driven by outside user needs.

Change and replacement of existing data management architecture and systems in TNO (DINO)

Developing the BRO database and data architecture represented a change from 'best effort' to best practice and standardisation.

BRO is based on a new and distinct data architecture, database system, and quality control process to DINO. Subsurface data are defined in 26 different subsurface data types in BRO – 'registration objects'. Registration objects are defined on their location and time-scale and are grouped into 6 themes, or 'domains'. This enables different types of subsurface data which have different life time cycles (e.g. borehole construction information, and groundwater monitoring data) to be stored separately in BRO. Related information can be linked (e.g. spatial location of a borehole and a groundwater-level measurement from that borehole). This design of BRO is the result of extensive discussions within TNO as to how best to define relationships between different subsurface data types, and also consideration as to how stakeholders use different types of subsurface data.

Data intake and data delivery will be facilitated by web services, with the BRO database sitting between the two sets of web services. TNO will be, therefore, be a provider of data and web services, as well as derived information and knowledge fixed products (2D or 3D maps and models) of geological interpretations.

Development of new data standards

For each registration object a new technical data standard has to be written to ensure the same number of parameters, the same level of descriptive detail for each parameter, and the same nomenclature are reported for each registration object.

The development of each technical standard is being done over a three-staged process, involving:

i. Early Stage - an initial draft standard is prepared by TNO and group of external experts
ii. Release Candidate stage - The draft goes on to consultation to a selected group of the professional user community – they review the usability of the draft within their daily processes.
iii. Public consultation – a revised version of the standard is developed by TNO based on feedback from the release candidate stage. The revised draft goes out for public consultation.
iv. Production version - based on feedback from the public consultation, a final version of the data standard is produced.

So far the process has been completed for one registration object – CPT data – and it is envisaged it will take 10 years for all 26 data standards, and standardised output formats, to be developed.

A key lesson learnt from developing the CPT data standard has been that even where a good existing technical data standards exists, multiple versions and interpretations of this data standard exist within the user community, and it can be very difficult to get everyone to conform exactly to one standard.

The importance of strong communication with the selected pilot partners in the professional user community is of vital importance to the ease of the development process, and the general acceptance and implementation of the standards in the future. There can be long time gaps between pilot partners providing feedback on a draft standard and revised versions being produced. Maintaining communication with the pilot partners in this process is vital to ensure they maintain a feeling of ownership to the process and the data standards developed.

The data standards are being developed in line with EU INSPIRE directive to give greater weight and buy in to the standards by the professional community, although the experience so far has been it the technical specification of the INSPIRE requirements is overly complex and quite difficult to meet.

Development of new standardised data format

As well as developing specific technical standards, TNO has also needed to develop a standardised data reporting format for the registration objects, to be able to achieve an automated data input to BRO.

A set data reporting format did not exist in the professional user community prior to BRO in the Netherlands – data were largely still being reported between contractors and consultancies and the survey in a variety of formats, including PDF. In the development of DINO, some effort had gone to encouraging adoption of an agreed format 'WellSSB' which was generated by TNO software (BORIS). However, it was not a contractual or legal requirement to use the format to submit data to DINO, and as a result there was limited uptake and use of the format.

For BRO, TNO are developing a XML file format structure for each of the 26 registration objects. Some fields within the XML file structure are compulsory, and if not completed the file will fail validation. For example, each registration object file must have a grid reference entered, and in the case of groundwater-level data, the datum of the groundwater-level measurement must be known. The XML file structure currently does not enforce compliance to the technical data standard – but this is proposed for future development work.

A wide range of IT capacity exists within the professional user community. A significant amount of effort went in to selecting pilot partners who had high IT capacity to ensure a good trial of the XML file structures could be achieved with outside users. However, a key lesson of the work to implement BRO has been the realisation there is generally a low level of IT capacity within the outside professional community. As a result, to implement BRO TNO have had to provide the user community with the programming code to generate both the XML file structures, and the standardised subsurface dictionaries. The only IT work required from the user community is to populate the standardised XML data structure with the appropriate subsurface data in the correct place. Providing guidelines and instructions on how to write the relevant programming code is insufficient to achieve and implement standardisation of the data type.

Validation of input data

Under BRO manual processing and validation of data intake to the geological survey will not be possible, and a fundamentally different approach to data validation and use of data will be generated in the survey.

Data submitted to BRO will be checked for compliance to the technical standards, and to the XML file format. Data which is 100% compliance will be accepted and held within BRO. An email notification system will communicate the results of the validation to data suppliers, and detail an error log where files are non-compliant. A transaction register will exist in parallel to the key register (BRO) recording all data submissions, validation results, and hold files pending correction for a fixed period of time.

The validation will not check the accuracy of the information entered into the XML files. If errors are found to exist to the accuracy of a subsurface data object in BRO (e.g. when the data are input to a model) TNO will not be able to correct or revise the data. This is a key difference between the data management of DINO and BRO. In BRO, it is envisaged data will be corrected in a feedback process: a user will report a suspected data error to the survey; the survey will then investigate the reported error with the data supplier; if a correction is required, the data supplier will re-supply the corrected data to the BRO intake web service interface.

BRO will, therefore, transform the way in which the geological survey uses and processes subsurface data – both for its own use, and for the outside professional user community.

In the initial trial of the validation of CTP data none of the XML files supplied by the pilot partners were compliant, and it has taken several uses of the technical standards and data format by the pilot partners for standards to be fully understood and input files to be generated correctly. It is hoped as the professional user community become increasingly used to the BRO technical standards, and those of the INSPIRE directive, validation success rates will improve significant.

Validation considerations

The fundamental change in how data will be validated under BRO – i.e. only the completeness and format of data held by the geological survey will be validated, and not the quality or accuracy – poses interesting questions for the future:

- Will future iterations of the national 3D models developed by the survey increase or decrease in accuracy and resolution with inclusion of BRO data?
- How much of the DINO data – manually handled and validated for quality, but not completeness or standardised format – will it be possible to upload into BRO through the validation checks? It is hoped 80% of the data held in DINO can be transferred into BRO, but this is unknown.
- In the development of BRO system, it has become apparent that despite having a national key register of subsurface data in BRO, it will remain essential for third parties (e.g. consultancies, contractors) to retain their own private databases of subsurface data – otherwise there is no mechanism for the accuracy of data submitted to BRO to be cross-checked in the future if the accuracy of information within some data points is questioned.

Levels of web services

To help accommodate the different levels of IT capacity with the professional user community, two levels of web services have been developed for data intake, and delivery from, BRO.

- A web portal service – offers a more basic level service to which subsurface data can be uploaded – either using the XML standard format or non-compliant file formats (e.g. PDF). Manual delivery of data outputs from BRO in a range of formats will also be possible, initially, through a web portal service.
- Direct web services – users with a higher level of IT capacity can directly connect their own subsurface databases to the BRO database, adopting the BRO data architecture and system. This will enable automated upload and download of data to BRO using the XML standard file formats. The web services will offer a live connection, so users databases will update as BRO is updated.

Despite it being a legislative requirement (effective from August 2015) to submit all subsurface data to BRO using a set file format and to a specified technical standard, in reality, the lack of IT capacity within many smaller companies in the professional user community, will mean that some users in the first instance will continue to submit data to BRO using old file formats, to a web portal, rather than by automated upload using web services and standardised XML files. It is hoped this situation will exist for only a short time, and all users will be able to use automated web services and the XML file standards within 1 year. The web portal service and delivery of non-compliant data has been allowed in the initial period of BRO, due to it being essential to have capture of data from all users, and it having proven more difficult than expected for the user community to develop the required IT capacity to meet the legislation.

Data accessions

Data accessions (i.e. description of the purpose, origin, time, client and owner of data) will be submitted with each file upload to BRO. The information required to be submitted in the data accessions of each upload is minimal – the new legislation covering most aspects.

All data within BRO must be publically available within 5 years – embargos for mining and deep geothermal borehole data will only be permitted to be 2 and 5 years, respectively.

Work still remaining

- Only 1 of the 26 key register object data standards has so far been developed (CPT data). Work is due to start to develop the next 2 key register data standards in 2015 (groundwater monitoring and groundwater chemistry). It is envisaged it will take 10 years to complete all 26 standards.
- Formal committees, who will review and oversee each technical data standard, in the long-term, for each of the 26 data registers still need to be formally defined and set up. These committees are likely to be composed of a range of technical experts, professional users and

staff of TNO. They will be equivalent to the UK committees managing and reviewing the British Standards.

- The software and programming code which generates the XML file structure for users to submit key register object data, does not yet currently force compliance to the technical data standards (e.g. users are not forced to complete mandatory fields within the XML files, such as the borehole grid reference). Developing compliant XML file software is planned by TNO for future development of the BRO system.
- As yet the email notification system to notify users of receipt of data submissions and the outcome of the field validation has not been developed. This is a key area of development for the work, so that receipts can be used for proof of contractual fulfilment for consultancies and contractors to be paid. The need for such a system was overlooked in the initial development of BRO – it was anticipated legislative drivers would be sufficient.
- Formal sign off of the change in legislation is set to go through parliament (two chambers) and to be signed off by the King in August 2015 to become formally effective.
- Development of a range of delivery formats from BRO has still to be undertaken.

3.5 Cost-benefit analysis of BRO

The work to implement and develop BRO now comprises 25% (€3 million) of TNOs total budget. Management of data in a general sense takes a further €4 million, with the delivery and interpretation of geological knowledge through the mapping and modelling programme of the survey a further €6 million. TNO in its present form, therefore, places great emphasis to the development of high quality comprehensive datasets and national 3D modelling – acting as a data custodian and provider to the Netherlands, as well as delivery of geological knowledge and interpretation through national 3D models.

The cost of implementation BRO is, therefore, significant to TNO – both in terms of real budget allocation, and also, in a more general sense, the focus of the surveys programme to exclude a wider breadth of work in developing a greater number of data and map products. These costs of BRO, are however, seen to be cost effective. Utilisation of deep subsurface for gas extraction in the Netherlands is estimated to bring in around €15 billion to the Dutch economy. The potential costs of mis-management of the shallow subsurface are even greater – an estimated cost of €40 billion alone for damage to foundations of heritage buildings if groundwater-levels are mis-managed. The value of having access to more subsurface data, particularly shallow subsurface data, is therefore, huge.

A key lesson learnt through the BRO work process, is a significant commitment of government and survey staff time and budget, are required to implement a new key register of data. In the initial phase of preparatory work to implement BRO the work was significantly under-resourced by the Dutch government, when in fact the work required 3 FTE staff in the national government, as well as in TNO.

3.6 More data, higher expectations - managing expectations

TNO is now the custodian and manager of a key national register of subsurface – this has raised expectations of the outside sector to the quality and range of geological outputs and interpretations which the survey can be expected to deliver – e.g. delivery of 3D national models of higher resolution and lower uncertainty with inclusion of more data; more rapid update of the 3D models under the automated data intake process to the survey in BRO.

TNO currently develops and manages 4 national 3D geological models of the Netherlands:

- GeoTOP – upper 30 m of shallow surface. Ultiises all available borehole data and subsurface data within DINO
- DGM and REGIS –models the upper 0-300 m of subsurface, in terms of 3D geology (DGM) and groundwater (REGIS). Utilises a sub-sample of the total available subsurface data available (approx.. 16,000 points)
- DGM deep – models deep subsurface for geothermal and gas energy extraction purposes.

The outputs of the GeoTOP, DGM and REGIS will be stored within BRO as three of the 26 key register objects in BRO. When the models are updated and re-run, the latest version of the model data will overwrite the previous model version stored in BRO. In this way, only the latest and most up-to-date version of the models will be accessible by the survey and all other end users, from BRO.

The models have in the past been updated on a 3-5 year time cycle, but a higher frequency of update and re-delivery of the models will have to be accomplished under BRO. More rapid update of the models should be feasible with BRO as a result of the automated intake process to BRO and standardisation of data. However, validation of the data input to the models will be very different – it only being the format and completeness of data which will be validated in BRO, and not the accuracy of the data itself. The impact this has to the 3D models can only be known once implementation of BRO commences. Increasing the density of data points within the models may also not have a significant impact to the resolution or accuracy of the models. It is likely a point of diminishing returns will be reached after a certain time, where the addition of more data does not significantly improve the model interpretation.

4 Key transferable lessons learnt from the BRO experience in Netherlands

Implementing automated ingestion of standardised digital subsurface data, represents and instigates more than just a change in data management within a geological survey – BRO will transform the way in which TNO can use data, the way the survey delivers data (through web services, 3D and 4D models) and the role of the survey to the professional user community – with greater emphasis on TNO as a data and web service provider.

Key considerations of this change are –

- *Data validation*: only the completeness and format of data held by the geological survey will be validated, not the quality or accuracy. This poses interesting questions for the future.
    - How much of the data previously held by the geological survey in its DINO database, which was largely validated for quality, but not completeness or standardised format, will it be possible to upload into BRO through the validation checks? It is hoped 80% of the data held in DINO can be transferred into BRO, but this is unknown.
    - Will future iterations of the national 3D models increase or decrease in accuracy and resolution with inclusion of BRO data (BRO enabling higher data input, but of lower quality validation)?
    - Having a national key register of subsurface data in BRO does not remover the need for the outside sector (e.g. consultancies, contractors) to retain their own private databases of subsurface data – otherwise there is no mechanism for the accuracy of data submitted to BRO to be cross-checked in the future if some data points appear erroneous in the future.

- *Prior to BRO, subsurface data capture and management (DINO) by TNO was very similar to that within the BGS and UK at present.*

  Prior to the move to develop a national key register of subsurface data (BRO), the legislative framework for reporting subsurface data to the Dutch government and geological survey was comparable to that at present in the UK. The surveys DINO database was composed largely of subsurface data generated in relation of the deep subsurface (that >30 m below ground surface) as required to be reported under the Mining Act and Water Law, and gas exploration. Data from the shallow subsurface was only deposited on a voluntary basis to TNO, as in the UK at present. As a result, a large amount of subsurface data remained held within individual private sector organisations and accessible only for a fee. In addition, data were reported to TNO in a large variety of formats, and input to the DINO database, with PDF still being common. This is comparable to the UK at present.

- *BRO will represent a fundamentally different database to DINO*

  DINO was a database developed by the survey, to hold the non-standardised subsurface data the survey held, for use by the geological survey (e.g. to help build the 3D models, and a range of national geological interpretations and advice). BRO is a comprehensive, formal, national register of subsurface data, which the geological survey will be custodian of, and provide access to, for the outside sector.

- *Implementation of legislative change (due to become effective in 2015) has been possible due to several favourable background conditions* – including:
  - Existing DINO database and 3D models – enabled TNO to demonstrate the advantage of having access and re-use of the centralised, comprehensive subsurface database to the government.
  - The move from 2D to 3D national modelling in 2000s
  - The recognition of the importance of the subsurface within planning, with the development of a new 3D 'layered planning' concept
  - The move to an 'e-Government' – increased automated ingestion of digital data to the survey and government was, therefore, attractive.
  - The direct levels of communication between TNO and the government – enabled strong lobbying for the need for the legislative change by the survey, and eventually for the commitment of sufficient resources to implement the change.

- *The implementation of the change has been relatively rapid, due to the commitment and significant investment by the geological survey both to instigate the change, and to develop the new data management systems.*

  The importance of direct access and communication with the government – both to implement the legislative change and determine role of the geological survey cannot be under-estimated to the work which has been achieved by TNO and in the implementation of BRO.

- *Importance of appropriate pilot partners in outside sector, and strong communication and relationships with these partners, for effective development of a new national data reporting system.*

  TNO found it difficult to find pilot partners in the outside sector who had sufficient internal IT capacity to fully assist and pilot the development of new data management and ingestion to the geological survey. Strong communication with the pilot partners was found to be essential throughout the development process to ensure the partners maintained feeling of ownership in the process – as there can be long periods between trial phases, and re-issue of revised templates following feedback. This highlights the importance of the opportunity presented by Scottish Water to pilot GSPEC nationally within Scotland.

5. Future collaboration and outputs

The COST STSM programme provides an unparalleled opportunity to COST participants and cities, to learn from each other and to gain an insight into the different approaches being developed in cities and countries to address common issues. It is only by developing this level of knowledge exchange that the COST group can really assess examples of best practice and examine the applicability of these to the range of COST cities.

Continued knowledge exchange:
Continued discussions and knowledge exchange on subsurface data management will almost certainly follow on from the STSM as work in these areas in both institutions progresses.

Engagement of wider group of COST participants:
It would be a natural extension to this STSM, to engage a wider group of COST participants to the discussions on subsurface data management, and increasing the re-use and impact of the data. This will be achieved through discussions of WG2.3 reviewing good practice of data management, and also in the development of the WG3 toolbox.

Outputs:
There is potential for a joint output between TNO and BGS on the work to implement BRO and alternatives, in implementing increased accessibility and re-use of subsurface data nationally

6. STSM Host institution approval / sign-off

TNO, March 2014

Michiel J van der Meulen

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