DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2009/16

Quality Assurance in Water Resources Modelling

NOVANAQuA

Anker Lajer Højberg & Jens Christian Refsgaard

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF CLIMATE AND ENERGY

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GEUS

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1. Dansk Sammenfatning

Nærværende projekt *NOVANAQuA* er finansieret under de tværgående indsatser under det national overvågningsprogram NOVANA. Hovedformålet med projektet har været at introducere kvalitetssikring i modelleringen udført indenfor NOVANA, og undersøge muligheden for anvendelse af en standardiseret metode til kvalitetssikring indenfor de enkelte programområder såvel som på tværs af disse. Projektet har indeholdt en test af softwareprogrammet MoST, der er udviklet under EU-projektet *HarmoniQuA* (www.harmoniqua.org), til at understøtte kvalitetssikringen af hydrologisk modellering. Testen er gennemført indenfor grundvands- samt landovervågningsprogrammerne med henblik på en identificering af mulige forbedringer til programmet for en tilpasning til danske forhold.

1.1 Projekt aktiviteter

Projektet blev igangsat d. 1. juni 2005 ved afholdelse af et et-dags seminar på GEUS. Her blev MoST samt NOVANAQuA projektet introduceret til en bredere kreds af aktører indenfor hydrologisk modellering i Danmark. I alt deltog 35 personer i seminariet repræsenterende vandressourceforvaltere (9) rådgivere (14), interessenter (3) samt forskere (9). Den overordnede konklusion fra dette seminar var, at der generelt var enighed om et behov for øget kvalitetssikring i forbindelse med hydrologisk modellering, og der blev udvist stor interesse for testen af MoST.

Under NOVANAQuA projektet blev MoST testet i to modelleringsstudier, ét indenfor landovervågningsprogrammet (LOOP), med deltagelse af vandressourceforvaltere, modellører og reviewer, og ét indenfor grundvandsprogrammet med deltagelse vandressourceforvaltere alene. Følgende institutioner deltog i testen af MoST under NOVANAQuA projektet:

- GEUS (koordinator, support til MoST, reviewer i LOOP model studiet)
- DMU (monitering af landovervågningsområderne, LOOP)
- Miljøcenter Nykøbing-Falster (vandressourceforvalter i LOOP og grundvandsstudiet)
- Alectia (modellør i LOOP modelleringsstudiet)

Udover testen af MoST i NOVANAQuA projektet, blev MoST indenfor samme periode afprøvet i forbindelse med opdateringen af den nationale vandressource model (DK-model), denne test var ikke finansieret af NOVANAQuA projektet, men erfaringerne herfra er medtaget i nærværende rapport.

Endvidere blev der i projektet opstillet et spørgeskema omkring kvalitetssikring i hydrologisk modellering. Spørgeskemaet blev gjort offentligt tilgængelig via nettet, og i alt 84 personer fra hhv. miljøcentrene, rådgivningsfirmaer, vandselskaber og forskningsinstitutioner blev via email indbudt til at deltage i spørgeskemaet. Sammenlagt gennemførte 38 personer spørgeskemaet fordelt på miljøcentre (14), rådgivere (13), vandselskaber (3) og forskningsinstitutioner (8).

1.2 Projekt konklusioner

Både testen af MoST samt resultatet af spørgeskemaet viste, at vigtigheden af kvalitetssikring i forbindelse med hydrologisk modellering er erkendt af samtlige aktører. Det blev endvidere fundet, at der generelt er en accept af, at en dokumenteret kvalitetssikring medfører en øget omkostning, og at der er villighed til at betale en sådan meromkostning. Spørgeskemaet viste imidlertid også, at der generelt ikke er specifik fokus på kvalitetssikring ved udførelse af modelstudier i praksis.

I spørgeskemaundersøgelsen blev det fundet, at udviklingen af nationale vejledninger for kvalitetssikring generelt blev bifaldt. Særlig udtalt var dette for ansatte i Miljøcentrene, hvor en sådan udvikling blev entydigt efterspurgt, ligesom der var stor tilslutning til udvikling af et software program til understøtning heraf. Udbydere af modelopgaver har et særligt ansvar i forbindelse med at opnå et øget fokus på kvalitetssikring af modelleringen i praksis, da disse har muligheden for at efterspørge dette og allokere de nødvendige ressourcer hertil. Årsagen til misforholdet mellem erkendelsen af vigtigheden af kvalitetssikring og den fokus der er herpå i praksis, skal sandsynligvis søges i manglen af nationale vejledninger. Uden vejledende principper samt understøttende værktøjer, kan det være svært for model udbydere at sikre en tilstrækkelig fokus på kvalitetssikringen.

Hovedparten af deltagerne i spørgeskemaundersøgelsen (82%) var bekendt med kvalitetssikringsværktøjet MoST, heraf besvarede mellem 11 og 17 spørgsmålene der adresserede MoST specifikt. Designet af guidance delen i MoST, dvs. principperne for god modelleringspraksis samt den udviklede modelleringsprotokol, blev vurderet som værende værdifuldt af langt hovedparten af deltagerne. Indholdet af guidancen delen, dvs. den skriftlige vejledning, blev ligeledes fundet velegnet, men dog ikke i samme udstrækning som designet. I modsætning hertil blev moniterings- samt rapporteringsdelen generelt ikke fundet velegnet.

Resultaterne fra spørgeskemaet er i overensstemmelse med de erfaringer, der blev opnået i fobindelse med afprøvningen af MoST. Her blev guidance delen ligeledes fremhævet som værende meget værdifuld. For den erfarne modellør kan den tjene som en tjekliste, mens personer med mindre erfaring kan støtte sig til den skriftlige vejledning. Model protokollen og vejledningen var endvidere vigtige til opnåelse af en fælles forståelse mellem samtlige aktører af en modelopgave. Mht. moniterings- og rapporteringsdelen af MoST var erfaringerne, at denne del var meget kompleks og svær at overskue, specielt for personer der ikke arbejde med tekniske programmer til daglig. Det blev pointeret, at det ikke var umiddelbart klart, hvor de enkelte delelementer af opgaven skulle dokumenteres i MoST, og programmet havde generelt en meget stejl læringskurve. Endvidere blev det fremført, at programmet spændte for vidt mht. funktionalitet, da det foruden en monitering af de udførte aktiviteter, indeholder funktioner for projektstyring. Denne funktionalitet er dog ikke tilstrækkelig for en samlet projektstyring, og det vil være nødvendigt at anvende et mere detaljeret værktøj, hvilket resulterer i dobbelt bogføring. I danske modelleringsopgaver er det gennem de senere år blevet mere almindeligt at opdele opgaven i faser, hvor hver fase afsluttes med et milepælsmøde. På disse møder præsenteres og diskuteres fremdriften af modelleringen og eventuelle ændringer i modelstudie planen besluttes. Forud for møderne udarbejdes en skriftlig rapport der dokumenterer modelleringsprocessen. Testpersonerne var meget opmærksom på vigtigheden af en detaljeret dokumentation af det udførte arbejde men fandt, at den dokumentation de ville foretage via MoST også skulle fremgår af de modelrapporter der skulle udarbejdes i forbindelse med milepælsmøder, hvorved dokumentationen i MoST bliver overflødig. Endelig blev det vurderet, at MoST ikke i tilstrækkelig grad er gearet til at facilitere en løbende dialog mellem klient og rådgiver, en aktivitet der i øvrigt blev fundet meget væsentlig i forbindelse med kvalitetssikring.

1.3 Anbefalinger

Det anbefales, at udviklingen indenfor for kvalitetssikring af hydrologisk modellering stiler mod en situation der er karakteriseret ved:

a) Modellering udføres i henhold til en *vejledning for god modelleringspraksis*, der er generelt accepteret og videnskabeligt funderet. Vejledingen skal sikre en fælles forståelsesramme blandt alle involverede aktører og minimere risikoen for konflikter opstået pga. uklarheder om procedurer og metoder.
b) Dokumentationen af modeljobbet skal sikre *gennemskuelighed* mht. de anvendte metoder, tilgrundliggende antagelser samt kommentarer fra alle involverede parter. Endvidere skal de dominerende usikkerhedskilder angives, og deres betydning for modelresultaterne skal fremgå klart.
c) Der skal tilknyttes en ekstern *reviewer* til modelopgaven.
d) Der skal skabes optimale betingelser for en *aktiv dialog* mellem alle aktører med fokus på at opnå en fælles forståelse samt skabe konsensus om den udførte modellering.
e) Der skal ske en dokumentation så modellen er *reproducerbar*. Dette er nødvendigt for at tredjemand kan foretage en auditering af modellen for vurdering af dennes kvalitet, udføre nye scenarier simuleringer samt ved opdatering af modellen eller tilstødende modeller.

Kvalitetssikring af hydrologiske modeller indenfor Danmark har været genstand for en betydelig fokus og udvikling i de senere år. Der er dog endnu behov for udvikling indenfor flere områder, før ovennævnte forhold vil være standard for modelopgaver. Som led i udviklingen i den skitserede retning anbefalinger vi følgende aktiviteter, der vurderes at kunne gennemføres indenfor en overskuelig fremtidig.

Nationale vejledninger. Udvikling af nationale vejledninger til at sikre, at modellering udført indenfor NOVANA samt de regionale Miljøcentre er baseret på et fælles sæt vejledninger for god modelleringspraksis. For at gøre disse vejledninger attraktive skal de:

- Være accepteret bredt af vandressourceforvaltere og rådgivere
- Blive opdateret regelmæssigt så de afspejler nyeste viden og erfaring indenfor hydrologisk modellering
- Være let tilgængelige på en måde, der sikre at brugeren altid er sikret den seneste version.

Guidance delen i MoST blev vurderet værdifuld af såvel personerne deltagene i testen af MoST samt deltagere i spørgeskemaundersøgelsen, og danner således et godt udgangspunkt for udarbejdelsen af nationale vejledninger. De nationale vejledninger bør dog udbygges med eksisterende tekniske og administrative vejledninger udviklet på nationalt niveau. Byggestenene for et nationalt sæt af vejledninger eksisterer således, men bør struktureres så de præsenteres for brugerne på en ensartet form. For at sikre en bred konsensus om vejledninger, bør de uarbejdes som *offentlige interaktive* vejledninger, dvs. de skal opstilles gennem opbygning af konsensus mellem aktørerne indenfor hydrologisk modellering, og inkludere såvel tekniske aspekter samt interaktionen mellem klient og rådgiver. I praksis betyder det, at de bør udvikles i et fællesskab mellem vandressourceforvaltere, rådgivere og forskningsinstitutioner. Vejledningen i MoST foreligger på engelsk, hvilket kun blev kommenteret af få i spørgeskemaundersøgelsen. Der var dog forslag om, at der som minimum skulle være en ordbog for de tekniske gloser. Det bør overvejes hvorvidt de nationale vejledninger skal foreligge på dansk, ulempen herved er, at det er mere tidskrævende at foretage en opdatering baseret på nye internationale udviklinger.

En regelmæssig opdatering af de nationale vejledninger samt en let tilgang hertil gør en web løsning mere favorable en udarbejdelsen af en sammenhængende rapport. Vi foreslår derfor, at der udvikles en hjemmeside, hvorfra den seneste version kan hjemtages. Hjemmesiden skal inkludere en historik for udviklingen af vejledningerne samt give mulighed for, at brugere kan komme med forslag til forbedringer. Der bør udpeges én institution til at varetage vedligeholdelsen af hjemmesiden samt sikre opdateringen af vejledningerne. Hjemmesiden skal ligge på en central server hvortil der er fri adgang.

Kommunikationsforum. En væsentligt del af kommunikationen under en modelopgave foregår via emails, men det bliver mere og mere almindeligt, at der oprettes dedikerede ”web hoteller” til lagring og udveksling af information. Ofte er disse løsninger struktureret af en projektadministrator, og strukturen for disse web hoteller er derfor varierende, hvilket gør, at det ikke altid er lige nemt at navigere til det relevante materiale. Endvidere indeholder disse løsninger ikke informationer relevante i forbindelse modellering og er derfor ikke medvirkende til at øge kvaliteten af modelstudiet, men anvendes alene som en ekstern lagring.

Vi anbefaler, at der udvikles en standard web løsning for et kommunikationsforum. Foruden at give mulighed for udveksling af materiale, bør den seneste version af de nationale vejledninger være gjort tilgængelig via løsningen. Der eksisterer en række freeware web løsninger, der med en relativ beskeden indsats kan tilpasses en struktur, der er i overensstemmelse med de opgaver der indgår i et modeljob, så brugeren bliver præsenteret for de dele af vejledningerne, der er relevante for den aktuelle fase af modelleringen. På baggrund af kommentarerne omkring kompleksiteten af MoST og dens stejle læringskurve anbefales det, at web løsningen udformes relativt simpel. Web løsningen bør gøres tilgængelig fra den hjemmeside, hvorpå de opdaterede vejledninger ligger.

Dokumentation af modelleringsprocessen. Testen af MoST og vurderingerne fra spørgeskemaet viste, at en detaljeret dokumentation af modelleringsprocessen er meget omfattende, og ofte fører til en dobbelt dokumentation, hvorved arbejdsbyrden og økonomien for et modelstudie øges betydeligt. Denne type af dokumentation er primært relevant under to situationer: 1) i kontroversielle studier, der har omfattende socioøkonomiske konsekvenser, og 2) internt i en organisation, hvor flere arbejder på samme modelopgave samtidigt. Til håndtering af sidstnævnte forhold har flere rådgivere i forskelligt omfang udviklet egne metoder og procedurer. Vi foreslår, at detaljeringen af dokumentationen af modelleringsprocessen aftales i forbindelse med det enkelte modelstudie, frem for udvikling af en standardiseret obligatorisk procedure.

Teknisk dokumentation. Den færdige model bør indlægges i den nationale modeldatabase. I denne forbindelse skal modellen dokumenteres på et detaljeringsniveau, der gør det muligt at genskabe modellen og de udførte simuleringer. Denne dokumentation skal ligeledes indlægges i den nationale modeldatabase. Et igangværende projekt har til formål at udrede og præcisere detaljeringen af denne dokumentation. Yderligere aktiviteter i denne forbindelse vurderes således ikke at være nødvendige.

2. Introduction

2.1 Need for Quality Assurance (QA) in modelling

Models describing water flows, water quality, ecology and socio-economics are increasingly being used to support water management functions and decisions. Stakeholders and decision makers are therefore often confronted with results from models whose underlying assumptions they, especially those without modelling background, have difficulty assessing. At the same time insufficient attention is generally given to documenting the predictive capabilities, the uncertainties involved and the limitations of models used (Refsgaard et al., 2005; Jakeman et al., 2006).

As a result of this development many modelling studies have produced results that were not considered credible or understandable by the water managers and stakeholders and that therefore were not utilised. This tendency is reflected in the increasing number of guidelines for good modelling practise that are appearing in these years (Refsgaard et al., 2005). A summary of reasons for the growing interest in Quality Assurance includes:

- Ambiguous terminology and a lack of understanding between key-players (modellers, clients, auditors, stakeholders and concerned members of the public);
- Bad practice (careless handling of input data, inadequate model set-up, insufficient calibration/validation and model use outside of its scope);
- Lack of data or poor quality of available data;
- Insufficient knowledge on the processes;
- Poor communication between modellers and end-users on the possibilities and limitations of the modelling project and overselling of model capabilities;
- Confusion on how to use model results in decision making;
- Lack of documentation and clarity on the modelling process, leading to results that are difficult to audit or reproduce;
- Insufficient consideration of economic, institutional and political issues and a lack of integrated modelling.

In the Danish water resources management community there is an increasing attention on quality assurance aspects in connection with modelling. This is probably most pronounced with respect to groundwater modelling, which by far is the largest modelling field in terms of turnover and number of jobs outsourced. The quality of the terms of references for modelling jobs has improved significantly, and the use of external reviewers has increased during the past 5-10 years. The groundwater modelling handbooks (Henriksen et al., 2001; Sonnenborg and Henriksen, 2005) and the courses in groundwater modelling, which have materialised based on initiatives from the water managers, originally in the counties – now in the environment centres, have played a major role in this process of bringing more attention to quality aspects of modelling.

2.2 The NOVANAQuA project

The present project, NOVANAQuA, is funded by the research and development programme under the Danish National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environment (NOVANA). The project was funded in 2004 and activities were carried out during the period 2005 to 2008.

The objectives of NOVANAQuA were to introduce QA of the modelling carried out within the NOVANA programme and to explore the possibility of using a harmonised methodology for QA in individual projects as well as across the various sub-programmes in NOVANA. The NOVANAQuA project utilised the software programme *Modelling Support Tool (MoST)* that was developed in the EU project HarmoniQuA to support quality assurance in hydrological modelling. MoST was tested in real-life, ongoing projects. Based on these experiences recommendations for the development of QA in hydrological modelling in Denmark are provided.

Apart from the LOOP and the groundwater case study, experience on use of MoST in the update of the Danish national water resource model (DK-model) has been included in the present report. Use of MoST in the DK-model study has, however, not been support financially by the NOVANAQuA project.

The partners involved in the NOVANAQuA projects were:

- GEUS (co-ordinator, MoST support, reviewer in LOOP case)
- DMU (agricultural monitoring (LOOP)
- Environmental Centre of Nykøbing Falster (MC-NYK) (water manager role)
- Alectia (modellers in the LOOP case)

2.3 The present report

The present report is organised in eight chapters. Following this introductory part a state-of-the-art in QA in modelling is given in chapter 3 that introduces some principles, terminologies and key aspects of QA in hydrological modelling. Chapter 4 provides a short description of the EU-project HarmoniQuA and presents the building blocks of the software programme MoST developed in HarmoniQuA. The studies in which MoST were tested are described in chapter 5 along with the experiences and views on using MoST for the different parties involved in the MoST testing phase. Beyond testing MoST the views on QA in hydrological modelling of a broader group was studied in the NOVANAQuA project by the organisation of one-day seminar and a web-based questionnaire. Results from these activities are present in chapter 6. Conclusions from the test of MoST and from the broader group are drawn in chapter 7. Based on the conclusions the report finalises by providing recommendations on QA in water resources modelling in Denmark, and identify the necessary activities.

3. International state-of-the-art in QA in modelling

3.1 Quality Assurance (QA) defined for modelling

Quality assurance (QA) can be defined as *the procedural and operational framework used by an organization managing the modelling study to build consensus among the organizations concerned in its implementation, to assure technically and scientifically adequate execution of all tasks included in the study, and to assure that all modelling-based analysis is reproducible and justifiable* (Scholten et al., 2007). This includes the organizational, technical and scientific aspects as well as the need to build consensus among the organizations concerned.

3.2 Guiding principles – three different approaches

Different approaches have been used to ensure good quality in water resources modelling. Inspired by de Groof et al. (2005) and Hansen and Grøn (2006) the approaches may be categorised according to three different guiding principles:

- *Regulation driven*. Performance is regulated by detailed standards on how to perform a study. These regulations often combine technical guidance and policy governed instructions linked to certain legislation. The regulations are typically issued by public authorities and have a status that makes it compulsory to subscribe to them. So this principle results in a centralistic top-down approach. The advantages of such regulations are that they often provide a transparent and operational set of rules for how to perform a given task for water managers, stakeholders and consultants. The disadvantages are that to provide detailed descriptions of what to do in all possible cases they become rather resource demanding and rigid. This approach is typically adopted for work carried out within public authorities. An example of regulatory driven guidelines is the UK Flood Estimation Handbook (IH, 1999; Packman, 2002) that provides detailed prescriptions on how to use various models to perform flood estimation. Another example is the set of Common Implementation Strategy (CIS) guidance documents aiming at supporting the WFD implementation (EC 2004a; EC 2004b). These CIS guidance documents are, however, broader than modelling and not very detailed, so they leave room for many different interpretations about how to do things and should therefore be combined with other approaches to assure good quality. A Danish example from this category is the guidance on how to make zonation in connection with detailed mapping of areas for groundwater protection (Miljøstyrelsen, 2000).
- *Expertise driven*. Performance is here governed by knowledge and experience from experts. This will result in delegation of modelling tasks to modelling specialists, who have documented experience and a well proven positive track record. In its ultimate way it may result in certification of certain tasks to individuals or organisations. This is a decentralised approach where the responsibility is entrusted to specialists. The advantage of this approach is that it allows knowledge and experience to be utilised in a flexi-

ble manner. The major disadvantage is that it is subjective in nature. Different experts may have different experiences and assessments, so the procedure is usually not reproducible and transparent. This approach is typically used in connection with consultancy services, where the client fully trusts the consultant.

- *Quality driven*. Modelling is here performed according to detailed technical guidelines, including a documentation of the quality of work. Examples of such guidelines are norms and standards. Such standards can ensure that all the important elements are considered. Furthermore, it may ensure that the study is carried out within a formal framework involving the entire organisation. The major disadvantage is that the standards can be very detailed and the formal documentation of quality typically requires a lot of bureaucratic work and hence considerable resources.

3.3 Type of QA guidelines for modelling

3.3.1 Classification

QA in the modelling process has two main components: (a) QA in development of model codes and (b) QA in relation to application studies. Here we focus on the second component only. QA in model application studies includes data analyses, methodologies of good modelling practice, reviews and administrative procedures. Such QA guidelines can be classified according to how much focus is put on the consensus building process between the modeller and the water manager in the following three classes (Refsgaard et al., 2005):

- *Internal technical guidelines (Type 1)* established and used internally by the modeller's organisation.
- *Public technical guidelines (Type 2)* established as public guidelines and used internally by the modeller's organisation.
- *Public interactive guidelines (Type 3)* established as public guidelines and based on regulation of the interaction between the modeller and the water manager throughout the modelling process.

If we refer to the three guiding principles (Section 3.2) both the internal and the public technical guidelines are typically quality driven, while the public interactive guidelines also to some extent are expertise driven.

Type 1: Internal technical guidelines
Most organisations involved in modelling studies have some kind of internal QA procedures. They usually focus on the technical aspects, i.e. to ensure that the modelling work itself is done without making unqualified judgements or errors. The betters of these are based on the modelling protocols and similar scientifically based procedures originating from the research community. These procedures are internal in nature because they have been established or adopted unilaterally by the modeller's organisation, and because they seldom deal with the interaction between modeller and end-user. Examples of Type 1 guidelines include:

- Internal QA procedures, common in many companies.

- Text books. Many textbooks contain chapters with recommended modelling protocols.
- Manuals to software packages with hints on the best way to use a model.

Type 2: Public technical guidelines
These guidelines often contain the same substance as the internal technical guides. However, they differ in the sense that they have been prepared through a consultative and consensus building process involving many persons and organisations. They focus on the technical aspects and give no or little emphasis to the interaction between the modeller and the end-user. Examples of Type 2 guidelines include:

- Standards from American Society for Testing and Materials (e.g. ASTM, 1994).
- The USGS guidelines for evaluating of ground-water flow models (Reilly and Harbaugh, 2004).

Type 3: Public interactive guidelines
These guidelines have, like the public technical guidelines (Type 2), been established through a public consultative and consensus building process. However, they differ from the Type 2 guidelines by an additional focus on regulating the interaction between the modeller and the water manager, who often have the roles of consultant and client, respectively. Important elements in public interactive guidelines are reviews that, in addition to QA in the sense of technical guidance, can facilitate the consensus-building process between the parties. Experience shows that such a process is crucial for the overall credibility of the modelling process. Examples of such QA guidelines include:

- The Dutch guidelines (Van Waveren *et al*., 1999; Scholten and Groot, 2002).
- The Australian groundwater flow modelling guidelines established by the Murray-Darling Basin Commission (Middlemis, 2000).
- The Danish groundwater modelling guidelines (Sonnenborg and Henriksen, 2005).
- Californian guidelines prepared by Bay-Delta Modelling Forum (BDMF, 2000).
- The HarmoniQuA guidelines build into MoST (www.harmoniqua.org).

3.4 Discussion of QA in water resources modelling

3.4.1 Key aspects in QA guidelines

Guiding principles
Quality assurance procedures are composed of a mix of the three guiding principles outlined in Section 3.2. For instance regulatory driven guidelines often prescribe use of (quality driven) standards for some of the detailed regulation. Most of the international guidelines listed above are quality driven, but with important expertise driven elements such as peer reviews and stakeholder interaction. As these guidelines are often used within a regulatory context, such as implementation of the Water Framework Directive (WFD), the quality assurance in reality becomes a mix of all three principles: (a) they are based on quality driven

guidelines providing recommendations on how to perform the technical details and how to manage the interaction between modeller, water manager and stakeholders; (b) they include subjective expertise in terms of peer reviews performed by independent external experts; and (c) they are most often carried out within the context of legislation prescribing that the work has to be carried out within the framework of certain regulatory guidelines.

A particular problem with some of the regulatory driven guidelines is that they are prescriptive with respect to methodologies including some times even which model code to use. As new knowledge appears the old methodologies and codes will inevitably become outdated. Therefore in order for such guidelines to be in accordance with state-of-the-art it is required that they regularly be updated.

Interactive guidelines

The dialogue between the different players is crucial to ensure that the output from the modelling process is understandable for stakeholders and beneficial for the client. The importance of involvement of stakeholder and public opinions is emphasised in many of the guidelines. In HarmoniQuA/MoST (Chapter 4), each of the five major steps is therefore concluded with a dialogue task, in terms of either contract negotiation (first step) or reviews (last four steps). A dialogue task encourages the assessment of the present step and provides the opportunity to redefine the content of the model study plan for the next step based upon the results and findings of the present step. These dialogue steps provide flexibility to the modelling study and ensure that the tasks that have yet to be performed can be modified according to the achieved results and perceptions of modeller and client.

Peer review

According to our experience the single most important instrument to ensure a good quality of the modelling process is to perform independent reviews of the modelling process. Like in the scientific tradition, peer review of the modelling work is the best way of evaluating the quality. Peer review is based on the principle of ‘expertise driven’ (Section 3.2) and is subjective by nature, which may be considered a weakness as compared to the more objective ‘quality driven’ guidelines with step by step descriptions of what to do. However, if we were not allowing the subjective element, we would deprive the process of the knowledge of experienced professionals and such knowledge is virtually impossible to convert to guideline text, because each modelling case is unique, while the guidelines have to be generically formulated. By combining the generic guidelines and the peer review we believe that we achieve the optimal mix of quality and expertise driven QA, and most of the existing guidelines emphasise peer review.

Transparency and reproducibility

Transparency and reproducibility are important, especially for large studies involving use of complex models. This is recommended in most guidelines. However, to efficiently implement this requires a supporting tool which enables modelling teams, consisting of modellers, managers and auditors, to be guided through the modelling process, to monitor all modelling activities and to oversee the status of each task to perform. With an increasing tendency to reuse existing models or rebuild them with additional data, modified conceptual models (revised model structure and/or inclusion of additional processes) and improved calibration and validation tests, such functionality becomes very important. To our knowledge the only existing tool dedicated for this purpose existing today is MoST (Chapter 4).

Accuracy criteria
Establishment of accuracy criteria for a modelling study is a very important, but difficult, issue. Modellers often establish numerical accuracy criteria in order to classify the goodness of a given model (Henriksen et al., 2003). These attempts are very useful in making the performance more transparent and quantitative, but do not provide an objective means to decide what the optimal accuracy criteria really should be in a given case. According to Refsgaard and Henriksen (2004) no universal accuracy criteria can be established, i.e. it is generally not possible from a natural scientific point of view to tell when a model performance is good enough. Such acceptance criteria will vary from case to case depending on the socio-economic context, i.e. what is at stake in the decisions to be supported by the model predictions. An appropriate question may be: how do we translate the 'soft' socio-economic objectives to 'hard-core' model performance criteria? This is obviously a challenge that can not be solved by natural science alone, but needs to be addressed in a much broader context including aspects of economy, stakeholder interests and risk perception.

Performance statistics must comprise quantifiable and objective measures. However numerical measures can not stand alone. Often expert opinions are necessary supplements.

Uncertainty assessments
Quality assurance and uncertainty assessments are two aspects that are very closely linked (Refsgaard et al., 2007). Initially, the manager has to define accuracy criteria from a perception of which uncertainty level he/she believes is suitable for a particular case (see *accuracy criteria* above). Subsequently, as the modelling study proceeds, the dialogue between modeller and manager has to continue with the necessary trade off between modelling accuracy and the cost of the modelling study. In the uncertainty assessments it is very important to go beyond the traditional statistical uncertainty analysis. Thus, e.g. aspects of scenario uncertainty and ignorance should generally be included and in addition the uncertainties originating from data and models often need to be integrated with socio-economic aspects in order to form a suitable basis for the further decision process (Van der Keur et al., 2008). Uncertainty assessment is included in almost all new guidelines. However, most of them only consider uncertainty assessment as something that needs to be done late in a modelling study together with the scenario simulations. The guidelines which most strongly emphasise that uncertainty should be on the agenda from the very first day and throughout a modelling study are HarmoniQuA's modelling guidelines.

Assessment of uncertainty due to errors in the model structure is a particularly difficult task and is most often neglected. One way of evaluating this source of uncertainty is through the establishment of alternative conceptual models (Refsgaard et al., 2006). Among the existing guidelines this aspect is most strongly emphasised in HarmoniQuA's modelling guidelines.

Model validation
Although experience shows that models generally perform poorer in validation tests against independent data than they do in calibration tests, model validation is in our opinion a neglected issue, both in many modelling guidelines and in the scientific literature. Maybe many scientists have not wanted to use the term validation due to the scientific philosophically related controversies, but in any case many scientists are not advocating the need for

model validation. One of the unfortunate consequences of this ‘lack of interest’ is that not much work has been devoted to developing suitable validation test schemes since Klemes (1986). In our opinion further development of suitable testing schemes, particularly for non-linear models and for applications comprising extrapolations beyond the calibration data basis, is a major future challenge.

Supporting software tools

Modelling is a complex process and QA is far from trivial. Therefore there is an obvious need for software tools to support QA of the modelling process. Such support is first of all required to document what is going on in the modelling process, so that the transparency and reproducibility can be improved. To our knowledge the only existing software tool dedicated for this purpose existing today is MoST.

3.4.2 Organisational requirements for QA guidelines to be effective

Modelling studies involve several parties with different responsibilities. The key players are modellers and water managers, but often reviewers, stakeholders and the general public are also involved. To a large extent the quality of the modelling study is determined by the expertise, attitudes and motivation of the teams involved in the modelling and QA process.

QA will only be successful if all parties actively support its use. The attitude of the modellers is important. NRC (1990) characterises this as follows: “most modellers enjoy the modelling process but find less satisfaction in the process of documentation and quality assurance”. Scholten and Groot (2002) describe the main problem with the Dutch Handbook on Good Modelling Practice as “they all *like* it, but only a few *use* it”. The water manager, however, has a particular responsibility, because he/she has the power to request and pay for adequate QA in modelling studies. Therefore, QA guidelines can only be expected to be used in practice if the water manager prescribes their use. It is therefore very important that the water manager has the technical capacity to organise the QA process. Often, water managers do not have individuals available with the appropriate training to understand and use models. An external modelling expert should then be sought to help with the QA process. However, this requires that the manager is aware of the problem and the need.

4. Modelling Support Tool (MoST)

4.1 The HarmoniQuA project

The HarmoniQuA project[1] aimed at developing a common, generic methodology, terminology and guidelines to support multidisciplinary model-based water management by developing a modelling Knowledge Base (modelling KB), building a Modelling Support Tool (MoST), testing these products, extending the project results to the wider professional community and raising awareness to use the developed methodology and tool to facilitate quality assurance and to make modelling projects more transparent (Refsgaard and Henriksen, 2004; Refsgaard et al., 2005; Scholten et al., 2007)[2].

4.2 Terminology and scientific philosophical basis

A key problem in relation to establishment of a theoretical modelling framework is confusion on terminology (Refsgaard and Henriksen, 2004). For example the terms validation and verifications are used with different, and some times interchangeable, meaning by different authors. The confusion arises from both semantic and philosophical considerations (Rykiel, 1996). Another important problem is the lack of consensus related to the so far non-conclusive debate on the fundamental question concerning whether a water resources model can be validated or verified, and whether it as such can be claimed to be suitable or valid for particular applications (Konikow and Bredehoeft, 1992; De Marsily et al., 1992; Oreskes et al., 1994). Therefore, HarmoniQuA has developed an internally consistent terminology and a glossary comprising more than 1000 terms.

The terminology and methodology are based on Refsgaard and Henriksen (2004). The most important definitions are:

- A *model code* is a generic software program, which can be used for different study areas without modifying the source code.
- A *model* is an application of a model code to a particular study area, including input data and parameter values.
- A model code can be *verified*. A code verification involves comparison of the numerical solution generated by the code with one or more analytical solutions or with other numerical solutions. Verification ensures that the computer programme accurately solves the equations that constitute the mathematical model.
- Model *validation* is here defined as the process of demonstrating that a given site-specific model is capable of making accurate predictions for periods outside a calibra-

[1] HarmoniQuA is an acronym for *Harmonizing Quality Assurance in model-based catchment and river basin management*. From 1 January 2002 to 31 December 2005, this research project was supported by the European Commission under the Fifth Framework Programme and contributed to the implementation of the Key Action "Sustainable Management and Quality of Water" within the Energy, Environment and Sustainable Development Programme. Contract n°: EVK1-CT-2001-00097.

[2] See for a complete list of publications: http://harmoniqua.wau.nl/public/Product/papers.htm.

tion period. A model is said to be validated if its accuracy and predictive capability in the validation period have been proven to lie within acceptable limits or errors.

4.3 The knowledge base

Guidelines for good modelling practise are included in the Knowledge Base (KB) of MoST. The modelling process has been decomposed into five steps, see the flowchart in Fig. 1. Each step includes several tasks. Each task has an internal structure i.e. name, definition, explanation, interrelations with other tasks, activities, activity related methods, references, sensitivity/pitfalls, task inputs and outputs.

The KB contains knowledge specific to seven domains (groundwater, precipitation-runoff, river hydrodynamics, flood forecasting, water quality, ecology, and socio-economics), and forms the heart of the tool. The most important QA principles incorporated in the KB are:

- The five modelling steps conclude with a formal *dialogue* between the modeller and manager, where activities and results from the present step are reported, and details of plans for the next step (a revised work plan) are discussed.
- *External reviews* are prescribed as the key mechanism of ensuring that the knowledge and experience of other independent modellers are used.
- The KB provides *public interactive guidelines* to facilitate dialogue between modellers and the water manager, with options to include auditors (reviewers), stakeholders and the public.
- There are many *feed back loops*, some technical involving only the modeller, and others that may require a decision before doing costly additional work.
- The KB allows *performance and accuracy criteria* to be updated during the modelling process. In the first step the water manager's objectives and requirements are translated into performance criteria that may include qualitative and quantitative measures. These criteria may be modified during the formal reviews of subsequent steps.
- Emphasis is put on *validation schemes*, i.e. tests of model performance against data that have not been used for model calibration.
- *Uncertainties* must be explicitly recognised and assessed (qualitatively and/or quantitatively) throughout the modelling process.

MoST contains descriptions of 90 different Methods that can provide support to the user on how to perform an activity. Examples illustrating the variety of Methods are 'Monte Carlo Simulation' comprising advice on how to perform Monte Carlo analyses and 'BMW Toolbox, which simply is a hyperlink (http://www.rbm-toolbox.net/bmw/index.php) to guidance on selection of an appropriate model code developed under another EU research project.

4.4 MoST – the supporting software tool

MoST supports multi-domain studies and working in teams of different user types (water managers, modellers, auditors, stakeholders and members of the public). The associated glossary is accessible via hyperlinked text. The key functionality of MoST is to

- *Guide*, to ensure a model has been properly applied. This is based on the Knowledge Base.
- *Monitor*, to record decisions, methods and data used in the modelling work and in this way enable transparency and reproducibility of the modelling process.
- *Report*, to provide suitable reports of what has been done for managers/clients, modellers, auditors, stakeholders and the general public.

A computer based journal is produced within MoST where the water manager and modelling team record the progress and decisions made during a model study according to the tasks in the flowchart. This record can be used when auditing the model study to judge its quality.

The screenshot shown in Fig. 2 illustrates the main work window of MoST. It shows the typical three panel layout under the *Project* tab for guiding and recording work on a specific *Task* within the modelling flowchart. The left-hand panel shows the sequence of *Tasks* completed or skipped, and highlights the current *Task 2.4: Model Structure and Processes* (which forms part of *Step 2: Data and Conceptualisation)*. Note that *Task 1.6: Proposal and Tendering* has been skipped as the work is being done ‘in-house”. The upper right-hand panel shows the (currently blank) model journal for an *Activity: Spatial resolution* currently open under the *Task*. The user can enter details of the actions and outcomes relating to this *Activity*, or can attach files or enter references relevant to the *Activity*. If suggested methods are available they will be listed to the right. The lower-right panel shows part of the guidance text on what the *Activity* should address**,** with hyperlinks to glossary terms. Each panel has a scroll bar and each can be resized.

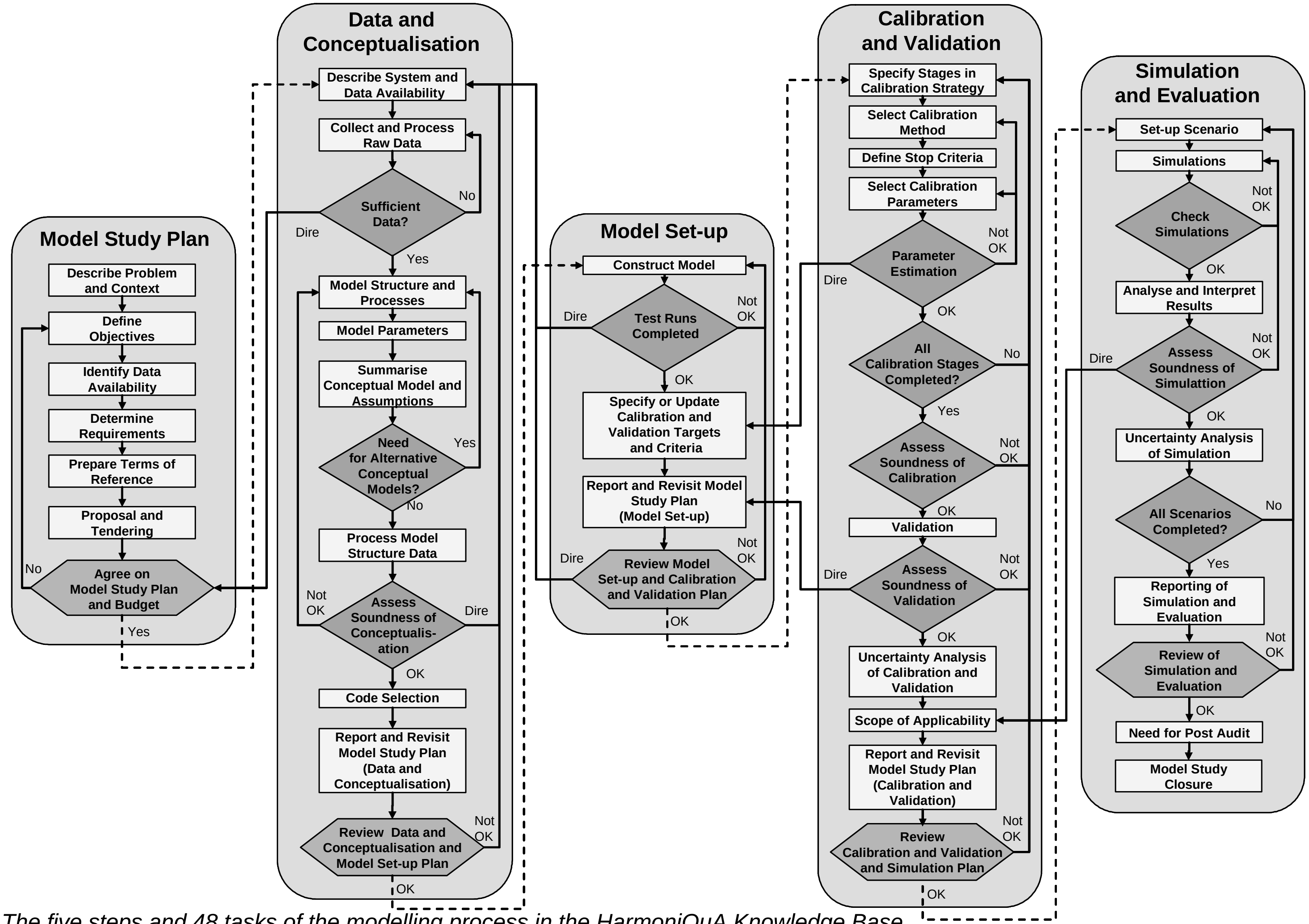

Fig. 1 The five steps and 48 tasks of the modelling process in the HarmoniQuA Knowledge Base

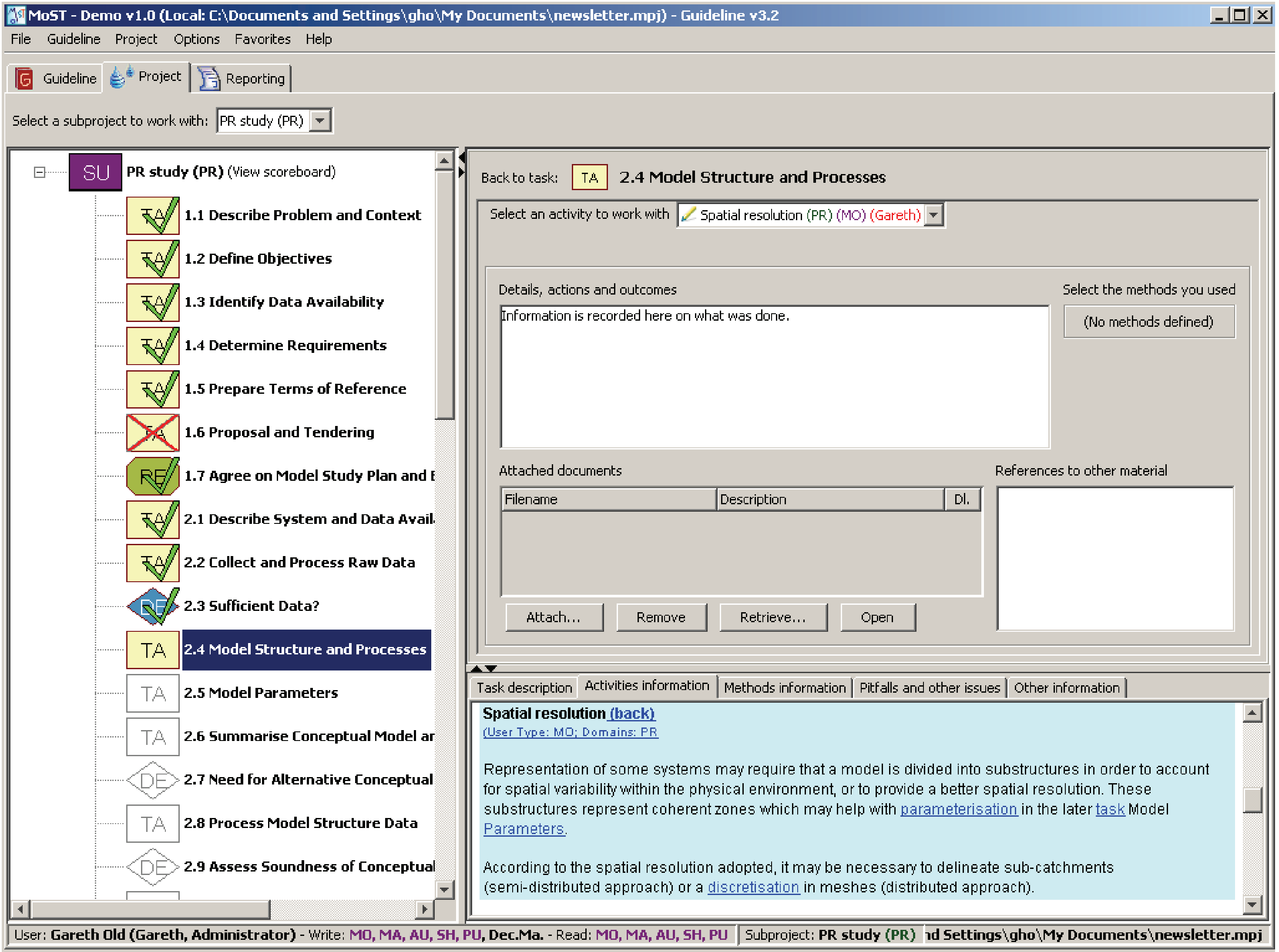

Fig. 2 Screen dump of the MoST tool

5. Experiences with use of MoST in Denmark

5.1 The LOOP 1 project

5.1.1 The project and the procedure of MoST testing

One of the sub-programmes under the Danish National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environment (NOVANA) deals with monitoring of five agricultural catchments (LOOP). These catchments are between 5 and 15 km^2 and have been monitored closely since 1990 with a focus on the fate of nutrients and the concentrations in soil water, upper groundwater, tile drains and streams (Rasmussen, 1996). In order to make full use of the very comprehensive monitoring data and gain improved understanding of the nitrate cycle in agricultural catchments it has been decided that each of the five catchments will be modelled using an integrated modelling approach. Environment Centre Nykøbing Falster (MC-NYK) under the Ministry of Environment has the responsibility for the LOOP1 catchment, Højvads Rende. MC-NYK decided to outsource the modelling study. MC-NYK had a budget of DKK 600,000 available for the modelling study.

The study was put in open public tendering in October 2007. GEUS was beforehand chosen as an external consultant to MC-NYK for providing input to the Terms of References and for performing external peer reviews of the modelling study. Six consultant consortia submitted proposals for the study. After the selection of the best proposal, it was decided by GEUS and MC-NYK to use this project as a modelling case study in NOVANAQuA. The selected consultant, Alectia, agreed to this. Since the study was selected as a MoST testing case after tendering, the first step of the HarmoniQuA modelling protocol *Model Study Plan* was not included in the testing phase.

The objective of the modelling study was to establish a dynamic, process based, spatially distributed catchment model for simulating flows and nitrate in the LOOP1 catchment. Results on nitrate leaching modelling carried out by DMU using the DAISY modelling system was provided as input to the present study. The modelling approach in Alectia's proposal was based on the MIKE SHE/MIKE 11 code with a 50 m horizontal discretisation and several vertical layers in the saturated zone, and inclusion of all river reaches and some of the tile drains in the MIKE 11 hydraulic model. Altogether simulations were performed for water flows (discharges, groundwater heads, water balances), particle tracking (groundwater age and flow paths) and advection dispersion (concentrations, nitrate mass balances).

The testing of MoST and the interaction between NOVANAQuA and the LOOP modelling study was carried out as follows:

- MoST was introduced at the kick-off meeting by GEUS. After some experiments and practical problems of using a local server for the project, it was decided to use the public MoST server at University of Wageningen for the project. Each of the three partners then used MoST during the project.

- In practise the LOOP1 modelling study was executed as planned. Thus the introduction of MoST did not result in changes in time schedule, sequence of work or content of work as compared to Alectia's original proposal. So NOVANAQuA was an amendment with almost no interference in the modelling study. In this way it was a real test of the suitability of MoST to a standard modelling study.
- The three actors MC-NYK, Alectia and GEUS were provided with small budgets from NOVANAQuA to compensate for the small additional extra work that the use of MoST, including the evaluation and reporting of MoST experiences, generated during the project.
- The modelling study was according to MoST an integrated modelling including three MoST domains: groundwater, precipitation-runoff and hydrodynamics. As the most important aspects of the study related to groundwater and In order not to make the MoST test too complicated, it was decided only to use the groundwater domain in MoST.

The persons that actively used MoST as an integrated part of the LOOP1 modelling study were:

- Water manager: Christian Fogt Andersen and Johan Lassen, MC-NYK
- Modeller: Thomas Wernberg and Oluf Z. Jessen, Alectia
- Reviewer: Jens Christian Refsgaard, GEUS

In addition three other staff members from Alectia were involved in the project. Anker L. Højberg, GEUS introduced MoST and provided support in setting up the server.

5.1.2 Water manager experiences and views

The MC-NYK team working as water managers and clients in the LOOP1 study has limited experience in modelling. Their colleagues in the groundwater group have considerably larger experience. The MC-NYK team expressed the following main experiences and views:

- An important asset in MoST is its potential as a tool to ensure that a modelling study cover the most important aspects, i.e. that you do not forget something due to ignorance.
- The guideline tool (MoST knowledge base) is very useful.
- The reporting tool is difficult and not so useful.
- There is a need for having a discussion on some of the key figures/tables. It would be nice if MoST could be better so that it is easy to facilitate a discussion on details in such figures/tables and store it for easy retrieval later by third persons.
- MoST or a similar tool could be an advantage in ensuring a harmonisation of procedures and exchange of information among the seven environment centres.

5.1.3 Modeller experiences and views

Alectia's experiences and views are described in Appendix A. Alectia's key conclusions are:

- The MoST knowledge base with its guidance is very thorough and well structured. This is very useful.
- MoST is not well geared to be a reporting tool. The reporting tool in MoST tends to result in double bookkeeping, because some of the things that are put into the Model Report to the client also need to be fed into MoST.
- It appears that MoST wants to do two things at the same time: (a) keep track of data inputs, model history, etc.; and (b) focus on project management issues such as keeping track on time and progress on tasks. As most consultant projects already use more advanced managing software, MoST should try not to substitute this part as it will lead to double bookkeeping.
- The central GUI needs to be reconstructed, so that the tool can become more dynamic and user friendly. The GUI should become more dialogue based, e.g. by establishing a forum for communication among the different actors.

In addition, Alectia identified a few minor bugs and suggested a number of ideas for possible improvements.

5.1.4 Reviewer experiences and views

The key findings from the reviewer are:

- A reviewer does not follow the project continuously. In the LOOP1 case the reviewer has provided work five times over a 14 months period, mostly in connection with technical review meetings. Therefore, a reviewer is not interested in progress of technical activities and preliminary results in between the meetings, but rather in the synthesised results contained in the modeller's reporting to the client.
- The guideline tool in MoST was useful as a checklist when performing a review. The time spend using MoST for this purpose was very limited (a couple of hours).
- The reporting tool was not of any use for the reviewer. In the present study the task of the reviewer was to check the end products by a peer review and not the details of the modelling process. This is the most typical type of review, and GEUS is not aware of more advanced reviews carried out in Denmark. The MoST reporting tool can probably only be useful for the reviewer in much larger and more complex projects where the reviewer is requested to carry out audits involving scrutiny of model inputs and possibly rerun of selected model simulations.
- The knowledge base and guidelines in MoST has an important function in creating a common framework for all the actors in the modelling study.

5.2 Geological mapping

5.2.1 The project and the procedure of MoST testing

For the protection of Danish groundwater geological mapping is carried out in areas designated as areas with special groundwater interest amounting to approximately one third of the country. The present study included the initial phase of such groundwater mapping project in which existing data, information and knowledge were assembled, stakeholders identified and model objectives defined. The longer term purpose of the study was the development of an integrated hydrological model in the Suså-Ringsted area located on the island Zealand in Denmark. The project was initiated by the Environmental Centre of Nykøbing Falster (MC-NYK) under the Ministry of Environment.

The project was selected in order to include the initial step of writing the Terms of Reference, a water manager task, in the MoST testing phase. The timeframe for MoST testing ended before the tendering task of the project, thus no consultants was involved in the MoST testing for this project.

The persons actively using MoST in the study were:
- Water manager: Lisbeth Møllerhøj and Mette Jørgensen, MC-NYK

Anker L. Højberg, GEUS introduced MoST and provided support during the test.

5.2.2 Water manager experiences and views

The MC-NYK team was not very experienced in preparing the Terms of References and did not have personal experiences in hydrological modelling.

The main conclusions from testing MoST were:

- The water managers acknowledged the need for guidelines and standardised procedures to improve the quality of model studies.
- The guidelines were highly appreciated. Writing proposals was not a trivial task to the water managers, and the guidance included in MoST contained issues that would otherwise not have been considered. The guideline thus provided a valuable checklist.
- Some Danish guidelines and recommended procedures exist for writing Terms of References, and the water managers would like those to be included as well.
- The MoST system appeared very complex and overwhelming, and a steep learning curve was experienced.
- From the flow chart and guideline descriptions in MoST alone it was found difficult to understand the structure, and especially found difficult to decide where to report what in the MoST reporting facility.

5.3 The DK-model at GEUS

5.3.1 The project and the procedure of MoST testing

By 2003 a National Water Resources Model (DK-model) was established covering the entire country (Henriksen et al., 2003; www.vandmodel.dk). Main objective of the model study was to conduct a more accurate assessment of the exploitable water resource at the national and regional scale. The model is composed of a simplified description of the unsaturated zone, a comprehensive three-dimensional groundwater component for estimating recharge to and hydraulic heads in different geological layers, and a river component for streamflow routing and calculating stream-aquifer interaction. The model is constructed on the basis of the MIKE SHE and MIKE 11 codes and by utilising comprehensive national databases on geology, soil, topography, river systems, climate and hydrology.

In the time span 2005 – 2009 the model is undergoing a major update. An important part in this process is an update of the hydrogeological model based on the extensive geological mapping carried out by the former counties, and a more detailed representation of the model input data and the numerical resolution. The model update is carried out in collaboration between GEUS and the environmental centres (formerly the counties). The centres have provided data, and together with GEUS decided on how the hydrogeological model best was updated based on their geological knowledge and existing geological and hydrogeological models. After the model update the centres have furthermore been responsible for a quality check on the updated hydrogeological model. All practical modelling aspects, i.e. data processing, setting up the model and model calibration and validation have been carried out at GEUS, where several modellers have been engaged in parts of the model building and/or running the model.

Altogether, numerous people have been involved in the update of the DK-model, and there has hence been a significant need for documentation and QA, both between GEUS and the regional centres as well as internally among the modellers involved in the model study at GEUS. It was therefore decided to test MoST in the model update project. This was accomplished by introducing the MoST system at a workshop held in an initial phase of the model study, with participation of all parties involved in the model study at a daily basis, i.e. key persons appointed for each county/environmental centre and modellers employed in the study at GEUS. The updated DK-model consists of seven submodels, and a MoST project was created for each submodel and made accessible to all relevant actors.

During the course of the model update, different key persons have been appointed to the project within the counties/environmental centres. Initially minimum one person from each of the former counties participated in the project. Following the structural reform, the counties were replaced by seven environmental centres, again represented by one key person. Although some of the key persons have been engaged in the entire update project, most have been replaced. In these situations experiences with MoST have seldom been transferred among the key persons, and the MoST activities by the centres have ceased. This means that the experience from the water manager’s site is limited in the DK-model project.

5.3.2 Experience and views from the counties and environmental centres

There has not been a formalised forum for discussing and extracting the experiences from the key persons at the environmental centres, but based on the experiences and activities with MoST, some general comments can be concluded:

- A common platform for communication and documentation was generally appreciated
- The guideline tool in MoST was considered helpful
- MoST was complex and difficult to understand
- Practical use of MoST was found time consuming

5.3.3 Modeller experiences and views

The need for thorough documentation was acknowledged among the modellers, especially as several modellers were employed in the construction of each of the submodels, by performing different tasks, such as data processing and setup of different domains in the model. The main conclusions from the test of MoST were:

- The guideline was helpful. For experienced modellers it could serve as a checklist, while the less experienced could draw from the descriptions included in the knowledge base.
- The structure of the reporting tool was not found optimal. While the guideline forms a logical flow and structure of a model study, it may not necessarily be logical to report at each completed task. An example is data processing, where documentation is most logically carried out by describing all tasks included in the collecting, processing and generation of model input files in a single document for each data type, rather than documenting each task separately for all data types.
- From a modeller's point of view, a major part in the QA is to assure that the work is documented in such detail that it can be reproduced. Often this requires a very detailed documentation that is best accomplished by the inclusion of graphics, such as screen dumps. MoST does not support graphic formats, and the documentation thus has to be made in a word processing software and attached to MoST. But since such documents are working documents altered continuously during the model course, it is attached to MoST only after the task is fully completed, and therefore not accessible to other. It was therefore found more adequate to store such documents on a shared network drive to make the document accessible to all modellers.
- With several modellers working simultaneously with the same model setup on different computers, there is a profound risk that model input files are updated at one computers without being updated at all other computers. Using MoST to avoid this from happening would be very cumbersome, since it would require that the modeller changing the inputfile should first report this in MoST, and then all other modellers should check MoST for updated files. Even with MoST running continuously it would be very tedious to find updates, since MoST does not keep track of recent changes. MoST was therefore not found suitable as a version control system.
- A model study is not linear process from start to end, but involves many loop backs, e.g. a first version of an updated hydrological model followed by an inspection by

the environmental centres leading to an updated version. The MoST guidelines acknowledge this non-linear process in a model construction and the reporting tool in MoST similarly supports loop-backs with in a study. However, keeping track of the different loop backs within MoST’s reporting tool is not easy in practice.

6. Views on QA in the Danish modelling community

In addition to the specific tests of MoST and the experiences and views obtained in this connection (Chapter 5) the views of broader groups within the modelling community have been obtained in the following ways:

- A seminar on quality assurance and modelling was held at GEUS on June 1st 2005.
- A questionnaire survey has been made.

6.1 Seminar on June 1st 2005

This seminar served as the kick-off of the NOVANAQuA project. The programme and list of participants are included in Appendix B. In total 35 persons representing water managers (9), consultants (14), stakeholders (3) and researchers (9) participated.

The objective of the seminar was to introduce MoST and the NOVANAQuA to the participants and get feedback on the interest for QA in modelling. The general conclusion from the seminar was that the participants in general agreed for the need of more focus on QA and that many were interested in following the results of the MoST tests.

6.2 The questionnaire survey

A questionnaire was developed focussing on the perceptions and experiences with QA in model studies. The questionnaire was organised in two parts. The first part concerned general aspects on QA in modelling and could be answered by all irrespective their experience with MoST. In this part five general topics were addressed:

1. Personal information (position and years of experience)
2. Expectations on what should be obtained through QA
3. Perceptions on the importance and key elements in QA
4. Practical experiences from model studies
5. Experiences and need for QA within the participants institutions

The second part of the questionnaire was targeting experiences with MoST, and contained two blocks:

1. Experience and impressions of the guidance provided in MoST
2. Experience and impressions of the reporting facility in MoST

Questions were posed as statements and the participants should indicate to which extend they agreed on the statements in a predefined scoring system that, in general, ranged between 1 (completely agree/very important) to 7 (completely disagree/not important).

The questionnaire was provided as a web application and all answers where made anonymously. In total 84 people were invited by email to participate in the questionnaire representing the environmental centres (24), consultants (36), water companies (6) and researchers (19). The questionnaire was located at a public website, and all invited were encouraged to distribute the link to relevant persons. The survey spanned a four week period, and a total of 38 people participated of which 6 did not complete the entire questionnaire. The number of answerers received by the different parties was: environmental centres (14), consultants (13), water companies (3) and researchers (8). The answers in the questionnaire were compiled for all participants and filtered by positions of the participants in order to highlight possibly differences. Some key figures from the total number of answers are found below, while all answers to the questionnaire are found in Appendix C.

All participants agreed on the importance of QA in modelling, Fig. 3, and 77% (score 1 and 2) found it acceptable that a documented QA resulted in an increase budget. Most participants also agreed that a national guidance would be valuable, whereas the idea of developing a standardised software tool to support the QA was less attractive. In the latter two questions, significant differences were observed between participants employed in the environmental centres and consultants. For the need of national guidelines the environmental centres agreed by 73% answering 1 and 18% answering 2, while the same figures where 23% and 38% for consultants. With respect to the need for a standardised software supporting QA the environmental centres favoured this by 35% answering 1 and 45% answering 2, while the consultants reply were 0% and 15% for category 1 and 2, respectively. Like the environmental centres, the water companies also acquire model studies from the consultants and occasionally acts as stakeholders. The answers obtained from the water companies differed from those from the environmental centres, which may reflect their different roles in different studies. However, only three persons representing the water companies concluded the questionnaire, and the survey may thus not reflect the general perceptions by this group.

Studying the importance of different aspects in order to obtain a good model quality, Fig. 4, it was found that the competence by the modeller and documentation that makes it possible to understand the principles and assumptions in the model were rated highest. This view was shared by all participants. However, as the only group the consultants rated the documentation higher than the competence by the modeller.

Compared to the unambiguous recognition of the importance of QA in modelling, the questionnaire revealed that QA is considered to a less extend in practice, Fig. 5. Fig 5 also illustrates that the general perception is that increased focus on QA during a model study is contributing to an increased quality of the study and that money spend on QA is well spend. Hence, there appears to be a mismatch between the perceptions of the importance of QA and common practice.

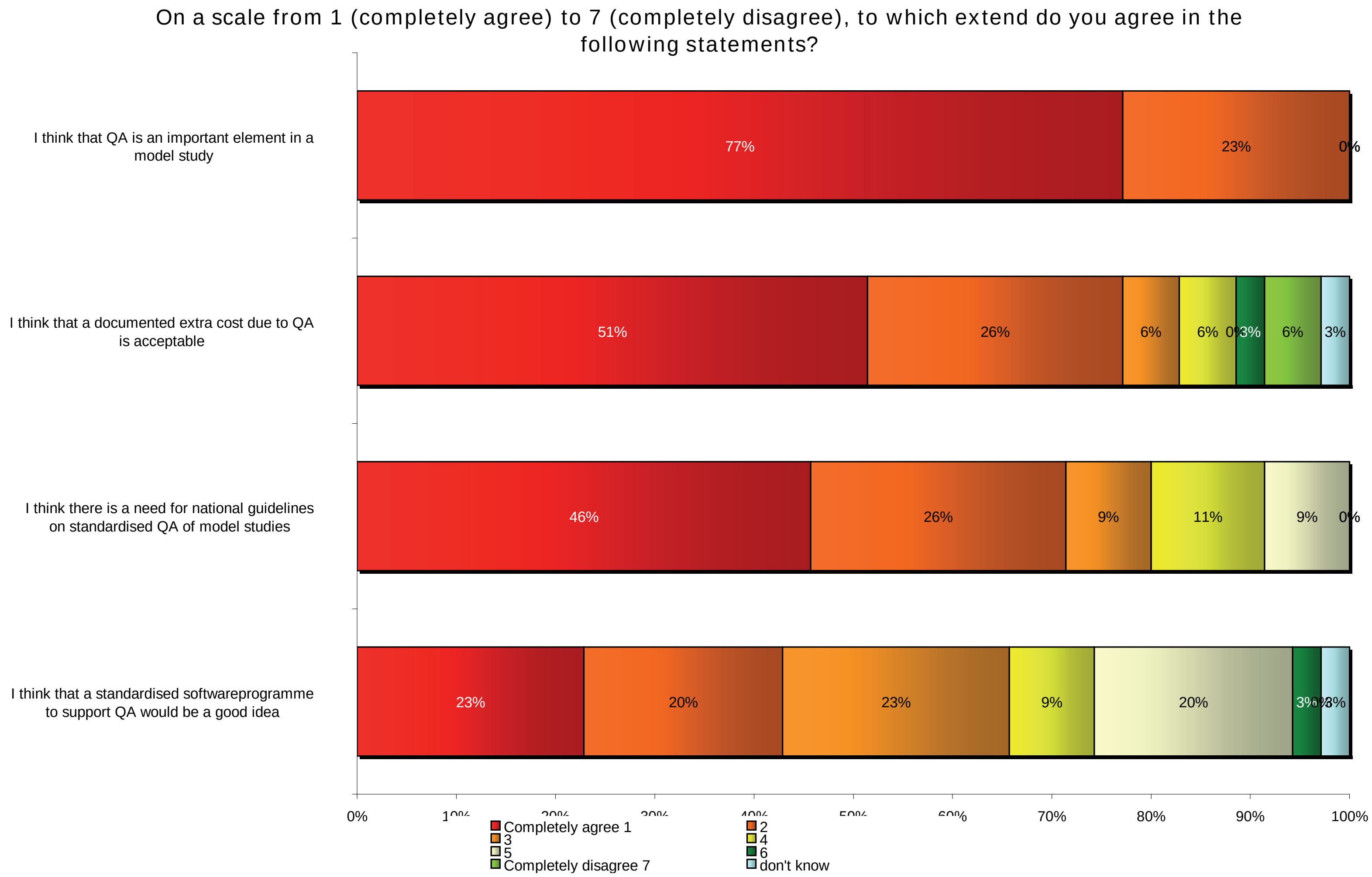

Fig. 3 Results from the questionnaire on perceptions on QA in hydrological modelling (all answers)

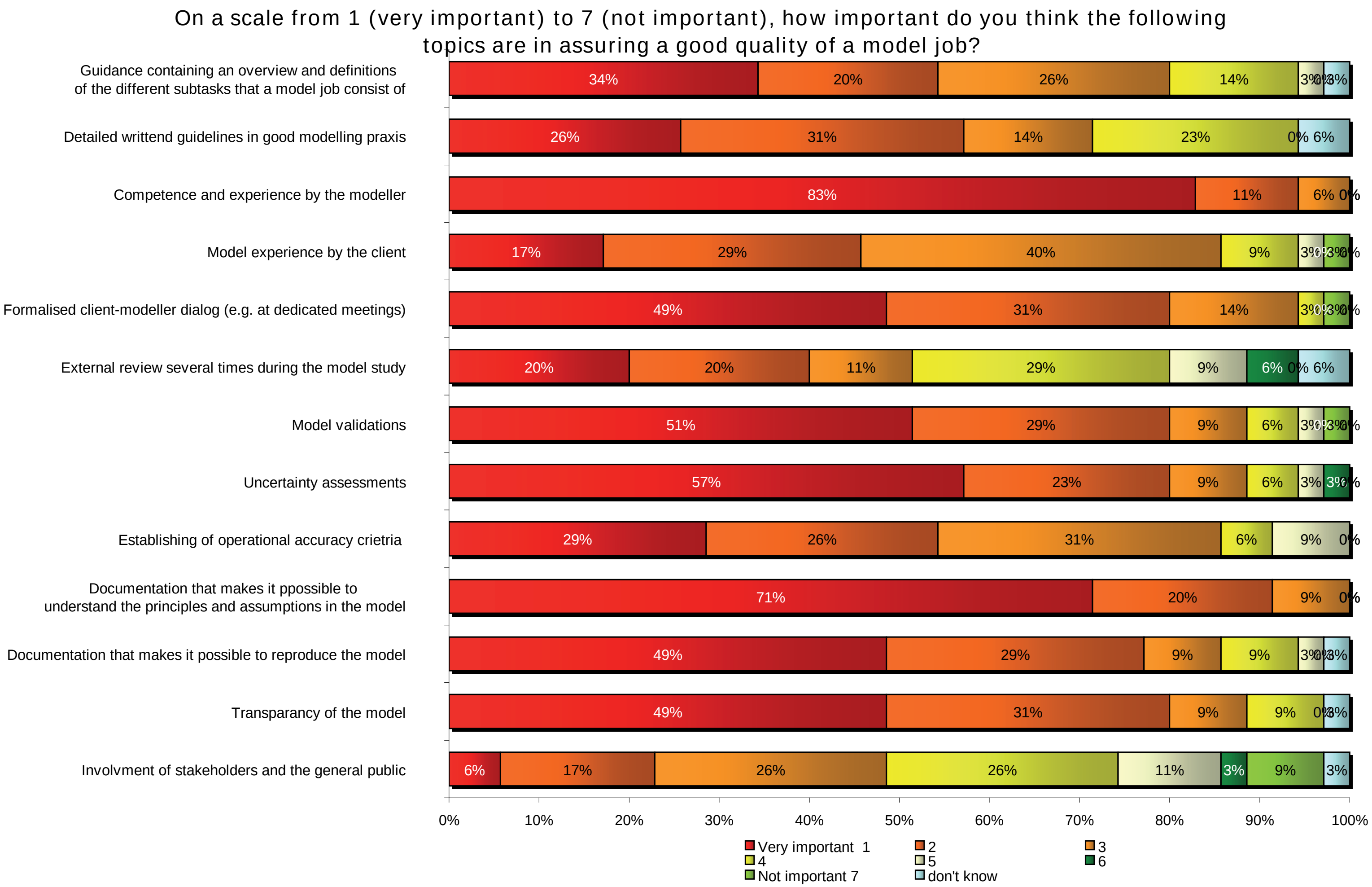

Fig. 4 Results from the questionnaire on the content of QA in hydrological modelling (all answers)

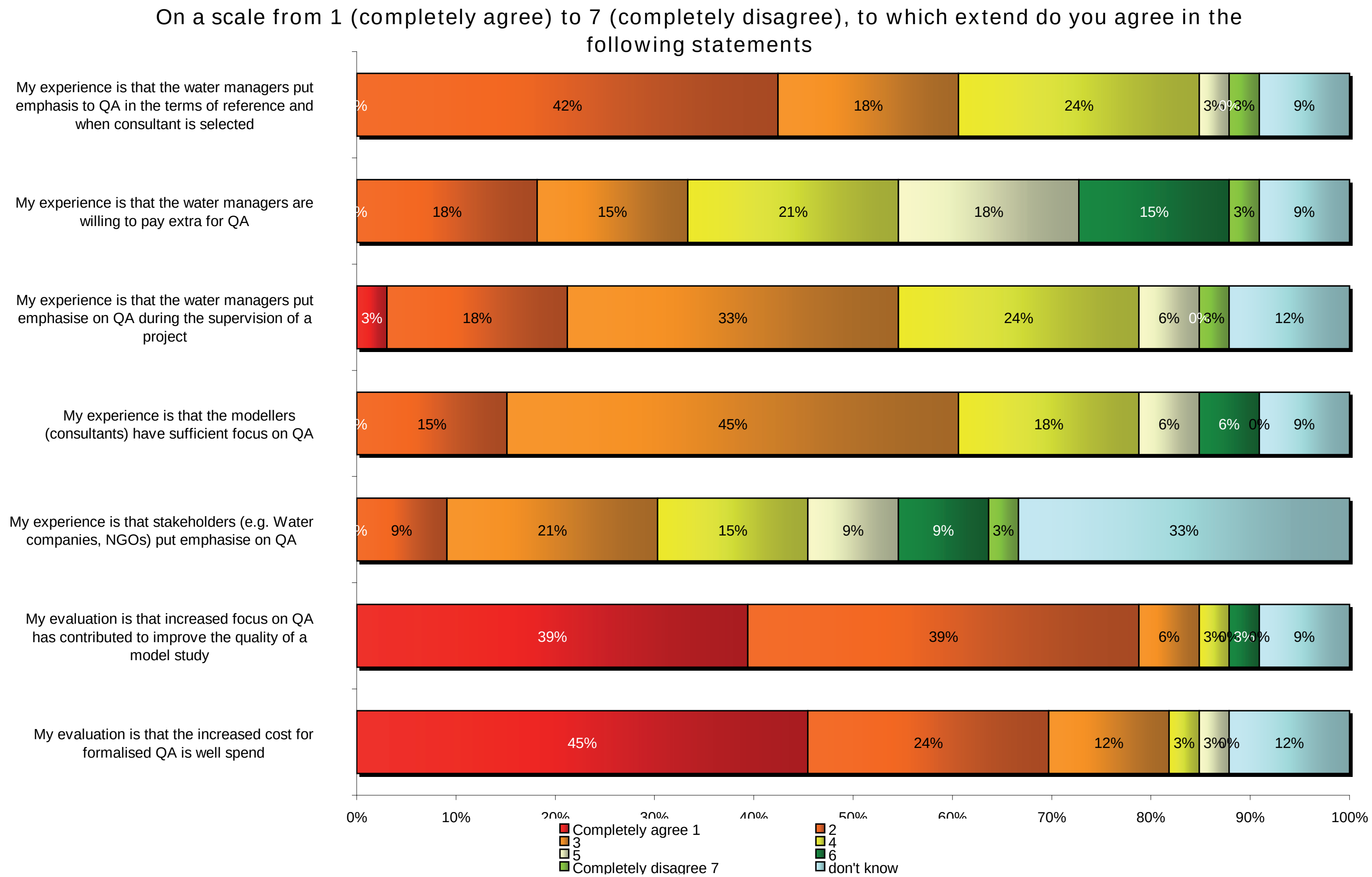

Fig. 5 Results from the questionnaire on the experience of QA in praxis (all answers)

The MoST software tool was known to most of the participants in the questionnaire, where 82% (27 persons) had heard or read about the program, while 42% (14 persons) had seen the programme and possible tested it to some extend. Of the 27 persons who had heard or read about MoST 24 persons completed the part of the questionnaire on MoST, but several answers were given in the category "don't know". Rated highest in MoST was the design of good modelling practice, i.e. protocol, principles, etc. included in the guideline, Table 1. Eliminating the "don't know" answers 17 persons provided an answer, with 7 rating the design of the guidelines by category 1 and 7 by category 2. Sixteen people provided and answer on the content of the guideline, which were rated somewhat lower, but the majority (12 out of 16) rated it within the three first categories, Table 1. The reporting facilities of MoST were rated significantly lower by the persons not responding "don't know", Table 2. Especially the usability of MoST during a model study was rated low, where 5 out of 13 persons completely disagreed to the statement *I think MoST is easy to use during a project*.

Table 1 Results from the questionnaire on the guidance part of MoST (all answers).

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements on the Guidance part of MoST?	**Completely agree 1**		**2**		**3**		**4**		**5**		**6**		**Completely disagree 7**		**don't know**		**Percent**	**Answers**
I like the ideas in MoST with respect to the design of good modelling praxis (protocol, pricnciples, etc.)	29%	7	29%	7	8%	2	4%	1	0%	0	0%	0	0%	0	29%	7	100%	24
I think the content of the guidance in MoST is good	8%	2	17%	4	25%	6	8%	2	8%	2	0%	0	0%	0	33%	8	100%	24
Total	19%	9	23%	11	17%	8	6%	3	4%	2	0%	0	0%	0	31%	15	100%	48

Table 2 Results from the questionnaire on the reporting facility in MoST (all answers).

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements on the reporting facility in MoST?	**Completely agree 1**		**2**		**3**		**4**		**5**		**6**		**Completely disagree 7**		**don't know**		**Percent**	**Answers**
I think the reporting facility is easy to understand	0%	0	4%	1	13%	3	13%	3	4%	1	8%	2	4%	1	54%	13	100%	24
I think MoST is easy to use during a project	0%	0	0%	0	4%	1	13%	3	13%	3	4%	1	21%	5	46%	11	100%	24
I think that most reporting facility was valuable to assure/improve the quality of the model job	0%	0	4%	1	8%	2	4%	1	8%	2	13%	3	8%	2	54%	13	100%	24
I thinkt that the reporting functionality fits well into the workflow of a model study	0%	0	4%	1	13%	3	4%	1	13%	3	4%	1	8%	2	54%	13	100%	24
Total	0%	0	3%	3	9%	9	8%	8	9%	9	7%	7	10%	10	52%	50	100%	96

7. Conclusions

7.1 Need for QA in modelling

Both discussions among the persons involved in the test of MoST and the questionnaire confirm that quality assurance in hydrological modelling is recognised as being very important among all parties in a model study. Furthermore, there is generally a willingness to accept an increased budget due to a documented QA. Driven by the Water Framework Directive (EC, 2000) involvement of stakeholders and the general public has received a much more prominent focus than has been the tradition in water management. Although the involvement of such parties is yet far from standard in model studies, the water managers in the MoST test cases were aware of this obligation and the extra focus this may pose on the documentation of the quality and the transparency of the model jobs that management decisions are based upon. The necessity of being able to document a model quality may thus be anticipated to increase further in the near future.

Despite the widely acknowledgement of the importance of QA, the questionnaire revealed that QA is considered to a less extend in practice. The Danish experiences thus confer with those observed internationally, where "they all *like* it, but only a few *use* it" (chapter 3). To enhance the QA in modelling it must be emphasised by the water managers when a model study is acquired. An important reason for the apparent lack of request on QA by water managers may be the lack of standardised procedures and methodologies supporting this, as indicated in the questionnaire, where participants employed in the environmental centres highly favoured the development of national guidelines and a software tool to support QA.

The development of a national guideline in good modelling practise for groundwater modelling in 2001 (Henriksen et al., 2001) and the later revision hereof (Sonnenborg and Henriksen, 2005) have had a noticeable effect on the groundwater modelling studies carried out in Denmark. One of the most important achievements by this guideline was that a common terminology and framework for groundwater modelling was obtained. Acknowledging that the geological model is the backbone for groundwater modelling a separate national guideline on geological modelling was recently developed (Jørgensen et al., 2008). The guidelines are both comprehensive reports and may not be known in detail to all, especially to those who do not routinely work with modelling jobs. To enhance the model quality in general there may thus be a need to disseminate the guidelines to a broader community by providing the knowledge and information in an easy accessible format, which are structured according to the working process of a model job, i.e. combine the national guidelines with the content and the structure of the guidelines in MoST.

It is important to emphasise that all model jobs are unique. It is therefore not possible to define a rigid guideline or flowchart that is valid for all model studies. The purpose of guidelines and flowcharts are therefore to provide suggestions for how things can be done, based on experiences obtained in practise or developed in the research community.

7.2 MoST

The modelling protocol and principles of good modelling practise included in MoST were appreciated by the people in the MoST test cases. For experienced modellers, the steps, tasks and activities comprised a useful checklist during the model study, while the less experienced modellers could draw from the descriptions in the knowledge base. The flowchart and guidelines also served an important purpose by defining a common framework for all parties in a study. The results from the questionnaire showed a similar approval on the guidance part of MoST, although the survey indicated that the content of the guidance could be improved.

The reporting functionality in MoST was not found optimal, neither among the participants of the MoST testing study, nor among the participants in the questionnaire. One argument among the participants of the test studies was that the reporting facility was very complex and overwhelming at first, which made the use of the tool less than appealing. This was especially a problem for water managers who did not worked with technical programmes at a daily basis. Once the users had grown accustom to the MoST interface and the navigation herein, several expressed their confusions on “where to report what”. The structure of reporting activities in the same order as in the guideline flowchart was not found intuitively. Often people found that they had reported some issues at one location, but later realised that this was probably not the correct place. The reporting tool was therefore described as having a steep learning curve, and it was anticipated that the tool had to be used in several studies before a logical structuring of the reporting was found. A more simple and flexible procedure for reporting were recommended. This view was supported by the questionnaire, where the MoST reporting functionality was generally not found to coincide with the workflow in a model study.

Beyond the reporting facility in MoST the software includes a facility to measure the time spend at the different stages of a study, and may hence be used in project management. This facility will, however, not be sufficient for complete project management, and a separate and more detailed management system will always be required. It was therefore recommended that such management system facilities should not be part of a modelling reporting tool.

In the LOOP 1 project, used as a test case for MoST testing, the model study plan included several review meetings, at which the model progress was reported and discussed among water managers, modellers and reviewer. Prior to each meeting a model report documenting the modelling activities was prepared and send to all parties. The content of the reports were similar to what the consultant would report in MoST, thus using MoST would result in double bookkeeping. Similar conditions would be anticipated for the majority of modelling studies in Denmark, where a model study plan generally includes several client-consultant dialogue meetings at which model progress is reported and discussed.

Although the importance of detailed documentation was greatly acknowledged by the consultant in the LOOP 1 project, it was pointed out that some routines/methods used in the course of a modelling study was developed by the consultants and treated as a business secret. Consultants may therefore be hesitant to report all parts of a study in complete detail.

An important objective of the MoST reporting tool is to improve the dialogue between the different parties in a model study. MoST's success in doing so was questioned by the participants of the test studies. A limitation in MoST in this respect is that when a person adds new information to the project, which the other participants of a model study should know, the person has to notify all others by email with direction to where the information has been provided.

8. Recommendations on QA in water resources modelling in Denmark

8.1 Vision

It is recommended that the development of QA in the field of water resources modelling should aim towards a situation characterised by:

a) Modelling is carried out on the basis of commonly accepted scientifically based *guidelines for good modelling practise*. Such framework will provide a common platform for water resources managers, modellers, reviewers, stakeholders and the general public that can minimise conflicts arising due to ambiguity on procedures and methodologies.
b) Modelling work should be reported in such a way that there is full *transparency* with respect to methodologies used, assumptions made, views expressed by all involved actors. Furthermore the most important sources of uncertainties and their impacts on the modelling results should be highlighted.
c) Modelling work should be subject to *review* carried out by *external* experts.
d) An *active dialogue among all involved actors* with the aim of achieving a common understanding and consensus on the modelling work is facilitated. Although such consensus will not necessarily extend to also include consensus on the subsequent management actions, it is an important basis for building mutual trust.
e) The modelling work is documented to such a detail that the modelling work is *reproducible*. This is relevant if somebody, e.g. a stakeholder, wants to make an audit of some model results, or if somebody, who was not involved in the original work, some years later wants to repeat a specific model run as a basis for further analyses. By the end of a modelling study the documented model is uploaded to the common model database at GEUS.

8.2 Specific recommendations for action now

Achieving a QA for water resource modelling as sketched above is realised to be a long term vision. To move in that direction we recommend the following actions that we believe are realistic to implement at a short term basis:

National Guidelines. A set of national guidelines should be established to ensure that modelling work carried out both within NOVANA and by the environment centres is based on a common set of guidelines for good modelling practise. For national guidelines to be attractive they should be:

- widely accepted by water managers and consultants
- updated on a regularly basis according to new developments and experiences within hydrological modelling

- easily available in a way that always provide the user with the most recent version of the guidelines

The MoST guidelines were rated high in the questionnaire and form a valuable foundation for the guidelines with respect to both content and the structuring. The guidelines should, however, be extended to include the existing technical and administrative guidelines developed at national level. The building blocks for national guidelines do thus exist, but need to be assembled and displayed to the users in a structured and uniform way. To assure a widely acceptance and approval, the guidelines should be developed as public interactive guidelines (see chapter 3), i.e. established through a public consultative and consensus building process, with focus on both the technical aspects and interaction between water managers and modellers. In praxis this means that the assembling of national guidelines should preferably be carried out in collaboration between the water mangers, consultants and the research community. Only few comments were made in the questionnaire on the fact that the MoST guidelines are in English, but it was suggested that a dictionary as a minimum should be developed translating the technical terms in the guideline to Danish. A complete translation of the guideline into Danish may be considered in the development of national guidelines, but the drawback to this is that updating based on international experiences and developments will be more labour intense.

A regularly updating of the guidelines and easily accessibility hereof favours a web solution compared to a standard hardcopy report. We therefore suggest the development of a web site from where the latest versions can be downloaded. The web site should include a history of the guideline developments, and provide a platform where users of the guidelines can comment on and provide suggestions for improvement of the guidelines. One institute should be appointed as responsible for the maintenance of the web-site and the update of the guidelines, and the web site must be hosted at a central server that is publicly accessible.

Communication Forum. Much communication in a model study is today solved by emails but more and more often different web solutions are employed to store and exchange information. Commonly these solutions are organised by an administrator creating folders similar to the file structure on a PC. The structure of these web solutions therefore differ from model job to model job making it not always ease to navigate to the relevant material. Furthermore, the web solutions do not contain model specific information, and do therefore not contribute to an improvement of the quality of the model study, but simply act as an external storage capacity.

We recommend the development of a standard web tool that can be used as communication platform in a model study, which, beyond the storage capacity, provides the users with the most recent versions of the national guidelines. Several freeware web solutions are available that, with a relatively limited effort, can be tailored to provide a structure that is in accordance with the tasks of a model study, e.g. like the steps and tasks defined in the HarmoniQuA project, Fig. 1. Relevant parts of the guidelines can then be provided to the users in the different stages of a model study. Based on the comment on the complexity and steep learning curve for MoST, the structure of the web tool should be kept relatively simple. The web tool should be made accessible from the web site also storing the guideline.

Reporting of the modelling process. The tests of MoST presented in this report and the perceptions from the questionnaire strongly indicate that detailed reporting of the modelling process is very cumbersome and often leads to double bookkeeping, which significantly increase the workload and thereby the cost of a model study. This type of documentation is primarily relevant under two conditions; 1) in controversial studies of socio-economic importance, and 2) internally in an organisation, where several people are working on the same model study. In the latter case, different institutions have to various degrees developed different methods and routines to document the modelling process internally, including standard structures for storing and updating model input files. Given the extra cost associated with a thorough documentation of the modelling process and the fact that routines to some extend have been developed by different organisations, we suggest that the degree to which the modelling process should be documented and how this should be done is decided on for each individual study, instead of the development of a standardised protocol.

Technical Documentation. The final model should be uploaded to the national model database. In this connection it should be documented in such detail that a model run is reproducible. This documentation should also be stored in the national model database. A national project is presently carried out, focussing on the detail at which a model must be documented, thus no additional activities are required in this area.

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Appendix A: Alectia report with modeller experience

MEMO

Sag	LOOP 1	Projektnr.	1997
Projekt	Quality assurance med MoST	Dato	2008-11-04
Emne	MoST evaluation	Initialer	thw

1 Background

As part of the national research project LOOP 1, ALECTIA has been asked to develop an integrated flow and nitrate model for a small catchment in the north-western part of Lolland (Denmark). The purpose of the project is to describe the flow processes in both groundwater and surface water in detail, and use this knowledge to model the nitrate processes in the same catchment. As part of the project an integrated surface water and groundwater model (MIKE SHE and MIKE 11) has been set up.

A part of this project has been to use the MoST system, and evaluate the usefulness of the system. This memo describes ALECTIA's experience on using MoST during this project. The experience is summarised at the end of the memo, and recommendations for future use and development are made.

2 Project organisation

The MoST project is based on the LOOP project, and as such includes all the participants from this project. This includes:

- ALECTIA has five employees on the project, including project manager, modellers and quality assurance.
- Miljøcenter Nykøbing Falster (MCNF) has 2 participants, including general project manager
- GEUS has 2 participants
- DMU has 2 participants. Due to limitations to the project and fundings, DMU's part in the MoST project is limited.

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2.1 Experiencing MoST – general comments

This section describes the user comments on using MoST during the LOOP project.

2.1.1 Login

When opening MoST the first view contains a long list of projects. Most of these projects are DEMO and Course projects, but there are also a few real projects. Some of these projects could be from other companies or organisations, and could contain sensitive information so they should not appear on a public list.

Once your project has been chosen, you are asked for a username / password and you can login to your desired project.

We recommend that the login procedure is changed, so that the user is only allowed to see the projects that one is allowed to work on. Hence you log on to the MoST server using your username and password and then you see a list of projects which YOU have access too. From this list you chose your MoST project and subsequently you don't see all the DEMO / Course projects and projects and potentially sensitive projects.

2.1.2 User Interface

The first impression of MoST is a huge GUI with many options. At first it seems like a very big task and it does require some patience to start using MoST. The GUI is not intuitive and there is a steep learning curve before MoST can be used in the daily work.

It soon becomes clear that the five columns on an essential part in the MoST structure and the work behind these columns is the general nerve of it. The columns reveal a fundamental understanding of the work progress in modelling.

2.1.3 Guidelines

The guideline tab is a very strong feature for the work process description. The interactivity between the guideline, flowchart and task view is excellent and gives a good understanding of what MoST is about. The overview of each step in the work progress and the help files connected to the Task Description, Activities Information, Method information, pitfalls and Other Issues and & Other Information are very informative. The linking to external references is very useful. The guidelines study has given lots of information about the work progress and is by it self a useful tool for improving the models.

From the project tab it is possible to follow the progress of the project. Each point can be activated, and later be assigned a ✔ when a task is complete and ✕ when a task is skipped.

The GUI to the project tab, however, is not intuitive to use, and it does not allow a proper documentation and dialog between participants, which is two very important steps in the quality assurance of model work. The evaluation and discussion will mostly consider this tab as it is the one the user will use the most.

The report tab generates reports for documentation, but we were unable to generate the required files (bug?).

2.2 MoST Update procedure

2.2.1 Date of change: Uploaded files and project activities

In the current version of MoST, the file upload can be improved by adding information such as who uploaded the files and when. This information can be of use when files are uploaded by several users or if a file is updated, and a list of documents can be made special to improve the documentation overview. The same concerns project activities: A date when a change / addition have been applied would be useful for the users of MoST.

2.2.2 Document update in Most

A case of an update procedure in MoST: The Model auditor updated a post with a description of some of the important steps in using MoST. The update was notified by email to the relevant participants in the Project. It was not initially possible to locate this updated information in the MoST project without manually stepping through each task in the task tree looking for the notification. We recommend that there should be a filter to isolate or highlight tasks with changes since last login.

The update should be much more automatic. Once the update has been applied to MoST, the involved participants could (or should if they are rare guests) be notified by an email saying that MoST has been updated, eg. section 2.4 by someone – And then a direct link to the change should be included or similar to the post. The content of the update should not be emailed around between the participants.

2.3 Discussion

2.3.1 Storage location

In the present application, the data is uploaded to an external server which stores HarmoniQua. A local server could have been setup for the project, but it was chosen to use the external server. For domestic use, the data storage server should idealistically be placed at GEUS, as GEUS in the future should store all national developed models.

2.3.2 Secrecy of business methods

As a private consultancy company, some of our solutions are unique and it is not in our interest to describe these solutions in detail. Even in the project proposal, many steps in the work progress described herein are from the company part of view considered private business. This is partly in conflict with MoST as each step should be described in detail. However, practically for the above conditions, this is not possible and at the present stage, the reporter has to consider whether input is violating business secrets or not.

This is actually a problematic step which should be discussed in general.

2.3.3 Missing participants

In this project, a participant upon initiation of the project announced that they were not interested in using MoST. In this case the participants are responsible for delivering data to the modellers. In this situation, it was decided to let the modellers / project manager describe the data input from the missing participant, but here we can only get a limited data input to MoST as all the experience and knowledge regarding the data handling and experience lies within the missing participant.

2.3.4 Communication and goal

After working with MoST some time it becomes slightly unclear whether MoST is a quality assurance program or the focus is more project managing. As quality control software, the general focus should be to keep track on all data input to the model as well as the history of sub models. As a project managing system, focus should lie on time managing and track keeping on tasks. It appears that MoST wants to do both, however most projects already use more advanced project managing software and MoST should not try to substitute this part as it will lead to double bookkeeping.

Also, at present time, MoST also has a tendency to become a reporting tool. Using MoST as a reporting tool results in duplicating work that is done in other applications. MoST is not geared to be a reporting tool and the handwritten report contains the information of which some is required in MoST aswell. After the handwritten report is generated, it is uploaded to MoST, and the modeller then has to fill out task points already written within the report. This kind of reporting is double work and not possible for projects on a tight budget.

2.3.5 Each task requires a dialog between participants

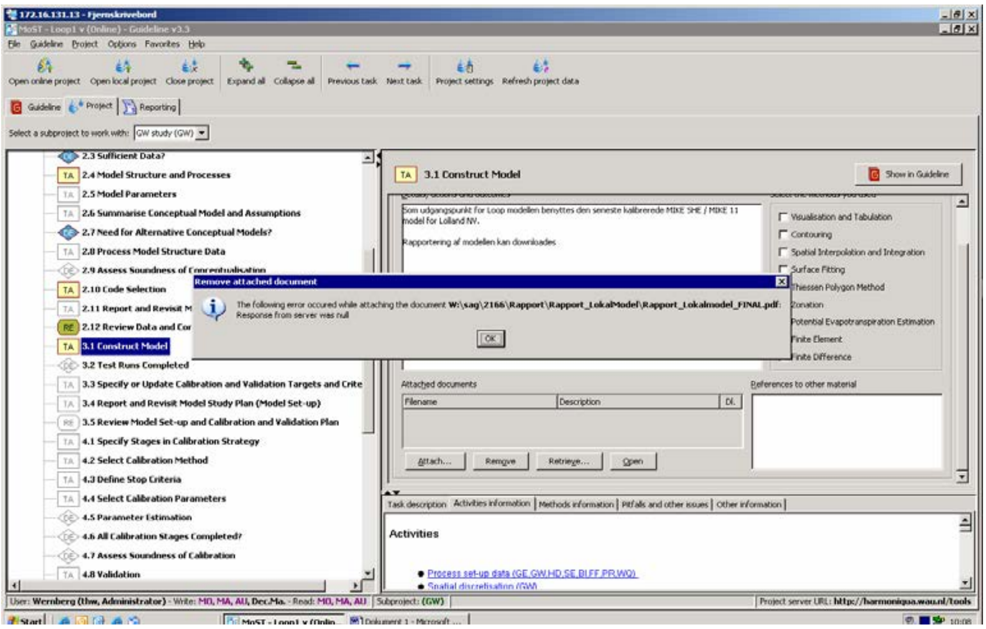
On task level, it should be possible to have an open dialog between the participants of the project. As an example from a current project, the geologist had a proposal of boundaries of the geological model which did not cover the groundwater model boundaries. In this situation a comment to the existing task description would be sufficient, but a reply is not possible, and a new task description had to be opened. This caused the historic timeline to be disrupted and limits the possible dialog between participants on the project. A structured forum would be sufficient to fulfil this issue.

Dialog between participants is one of the most important steps in a successful model work. It is more important than defining who has access rights to where and when, and the possibility to create this dialog should be very easy and not restricted. Therefore we recommend that the GUI becomes more dialog based. A test example of a forum with some of the MoST steps are made at the following url: http://www.wt-software.dk/MoST (It is a demo page set up to show some ideas. Login and confirm your login via your email).

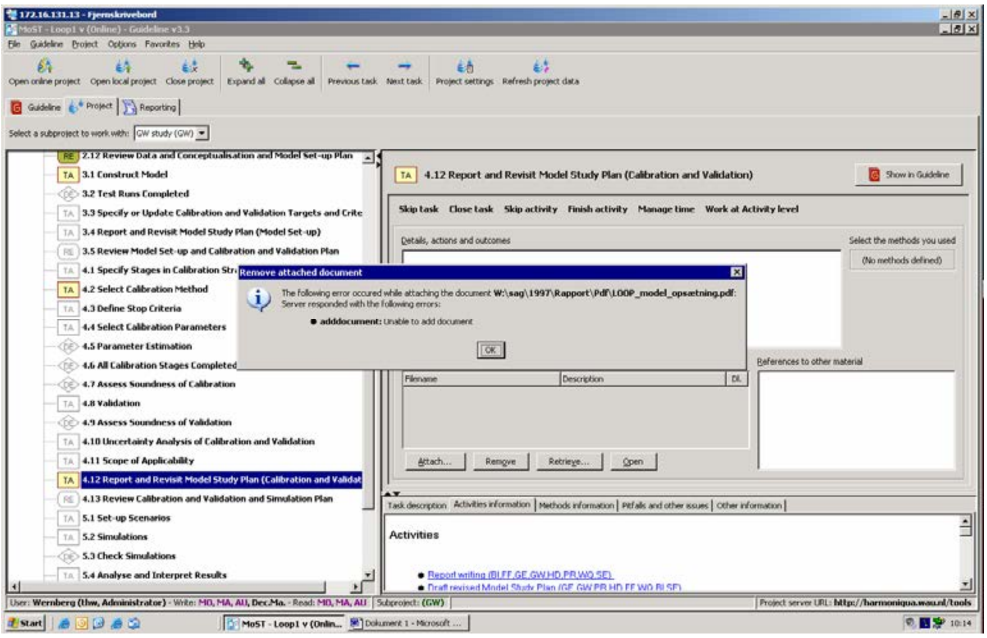
Note that this is just an example of how the participants can interact, read the latest posts, up and download files and – most important – sustain an ongoing dialog. Note that the forum has been organised in correspondence with the MoST flow diagram. For each step, a forum is made (which may not be necessary), and under each forum a topic can be made. Section 2 is made into a detailed forum and section 2.4 shows an example of help text and dialog. The forum of section 3 and 4 is less detailed but also shows examples of conversations and achieving.

2.4 General Bugs

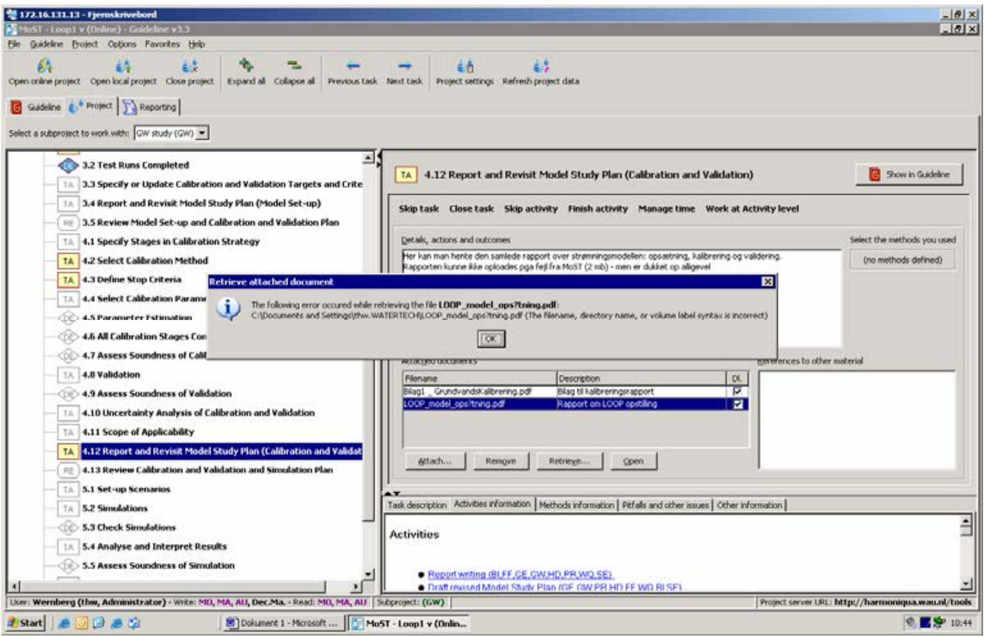
Working with MoST uploading files has shown to cause some problems. The error messages given could indicate that there is a limit to the size of the files to be uploaded (Figur 1), but also the Danish letters 'æøå' which are in one of the files could be an issue (Figur 2). After the latter error message, the file was actually uploaded to MoST several times (Figur 3).



Figur 1: Error message given to a file that could not be uploaded. The file size of 6 MB could be the limiting factor



Figur 2: Error message for a file uploaded of 2 MB of size and file name comtaining the danish letter 'æ'.



Figur 3: Error message when trying to retrieve a previously up-loaded file

2.5 Summarizing the experience with MOST and recommendations for future development

Where a quality control tool for modelling is a good thing, working with MoST did not provide us with the tool that can be used in the daily work. There are several reasons for this:

- Documentation is already written in external reports, and using MoST tend to become double bookkeeping
- The GUI is not user friendly and the following important steps were missing:
  - Check for recent updated points
  - Documentation upload has to be more flexible.
  - A forum is needed – communication is an important tool for quality control
  - The structure is too tight for daily use.
- MoST should not use any project handling tools

The quality control of modelling work must not take longer time that the present work. Hence, there should be a economical benefit to use a model quality tool.

We believe that the central GUI needs to be reconstructed, so the tool can become much more dynamic and user friendly. A modeller does not in general have time to work on the model, write the report and report the same to MoST.

MoST is very thorough and well structured concerning quality control of modelling. This is a very strong aspect and it is very useful as such.

Appendix B: NOVANOQuA kick-off seminar

Program for seminar om kvalitetssikring af modellering

GEUS, Øster Voldgade 10, 1. juni 2005

9.30 – 10:00	Ankomst og kaffe
Formiddag	
10:00	Velkomst, Jens Christian Refsgaard, GEUS
10:05	*Introduktion til kvalitetssikring af modellering og præsentation af HamoniQuA*, Jens Christian Refsgaard
10:30	*Behov for kvalitetssikring af modellering*, Jens Asger Andersen, Københavns Amt
10:45	*Behov for intern KS af modellering,* Kristian Bitsch, Rambøll
11:05	Behov for kvalitetssikring af modellering, diskussion i plenum.
11:35	*Kaffe*
11:55	*Involvering af interessenter*, Gyrite Brandt, Københavns Energi
12:15	*Præsentation af NOVANA projektet "Kvalitetssikring af modellering i NOVANA"*, Anker Lajer Højberg
12:30	*Præsentation af MoST,* Anker Lajer Højberg, GEUS
12:50 – 13:50	*Frokost*
Eftermiddag	
13:50	*Præsentation af MoST (forstsat)*, Anker Lajer Højberg, GEUS
14:20	*Erfaringer fra tidligere test og fremtidsperspektiver for MoST*, Jens Christian Refsgaard
14:35	Fremtidsperspektiver for en fælles nationalt kvalitetssikringsprocedure, diskussion i plenum.
14:50	*Kaffe*
15:10	*MoST Advanced - justering af MoST*, Anker Lajer Højberg
16:00	Mødet slutter

Deltagerliste

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Appendix C: Questionnaire

The answers in the questionnaire were compiled for all participants and filtered by positions of the participants: Employees at the environmental centres, consultants, water companies and researchers. The questionnaire was provided in Danish, but the summary has been translated into English in the representation of the results for all participants. Comments given by the participants are provided in the end of Appendix C, in Danish only.

Summary of all answers

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements on what to obtain through QA?	Completely agree 1		2		3		4		5		6		Completely disagree 7		don't know		Percent	Answers
QA must assure that the model report is without errors	40%	14	23%	8	20%	7	11%	4	0%	0	0%	0	6%	2	0%	0	100%	35
QA must assure that the model is without errors, e.g. erroneous input data or errors in the model setup	74%	26	26%	9	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	35
QA must assure that the final model is the best possible model based on the available data	49%	17	37%	13	0%	0	3%	1	9%	3	0%	0	3%	1	0%	0	100%	35
QA must assure that a mutual understanding on the models applicability has been reached among the person acquiring a model and the modeller.	49%	17	20%	7	17%	6	3%	1	3%	1	0%	0	9%	3	0%	0	100%	35
Total	53%	74	26%	37	9%	13	4%	6	3%	4	0%	0	4%	6	0%	0	100%	140

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements?	Completely agree 1		2		3		4		5		6		Completely disagree 7		don't know		Percent	Answers
I think that QA is an important element in a model study	77%	27	23%	8	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	35
I think that a documented extra cost due to QA is acceptable	51%	18	26%	9	6%	2	6%	2	0%	0	3%	1	6%	2	3%	1	100%	35
I think there is a need for national guidelines on standardised QA of model studies	46%	16	26%	9	9%	3	11%	4	9%	3	0%	0	0%	0	0%	0	100%	35
I think that a standardised softwareprogramme to support QA would be a good idea	23%	8	20%	7	23%	8	9%	3	20%	7	3%	1	0%	0	3%	1	100%	35
Total	49%	69	24%	33	9%	13	6%	9	7%	10	1%	2	1%	2	1%	2	100%	140

																	Total	
On a scale from 1 (very important) to 7 (not important), how important do you think the following topics are in assuring a good quality of a model job?	Very important 1		2		3		4		5		6		Not important 7		don't know		Percent	Answers
Guidance containing an overview and definitions of the different subtasks that a model job consist of	34%	12	20%	7	26%	9	14%	5	3%	1	0%	0	0%	0	3%	1	100%	35
Detailed writtend guidelines in good modelling praxis	26%	9	31%	11	14%	5	23%	8	0%	0	0%	0	0%	0	6%	2	100%	35
Competence and experience by the modeller	83%	29	11%	4	6%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	35
Model experience by the client	17%	6	29%	10	40%	14	9%	3	3%	1	0%	0	3%	1	0%	0	100%	35
Formalised client-modeller dialog (e.g. at dedicated meetings)	49%	17	31%	11	14%	5	3%	1	0%	0	0%	0	3%	1	0%	0	100%	35
External review several times during the model study	20%	7	20%	7	11%	4	29%	10	9%	3	6%	2	0%	0	6%	2	100%	35
Model validations	51%	18	29%	10	9%	3	6%	2	3%	1	0%	0	3%	1	0%	0	100%	35
Uncertainty assessments	57%	20	23%	8	9%	3	6%	2	3%	1	3%	1	0%	0	0%	0	100%	35
Establishing of operational accuracy crietria	29%	10	26%	9	31%	11	6%	2	9%	3	0%	0	0%	0	0%	0	100%	35
Documentation that makes it ppossible to understand the principles and assumptions in the model	71%	25	20%	7	9%	3	0%	0	0%	0	0%	0	0%	0	0%	0	100%	35
Documentation that makes it possible to reproduce the model	49%	17	29%	10	9%	3	9%	3	3%	1	0%	0	0%	0	3%	1	100%	35
Transparancy of the model	49%	17	31%	11	9%	3	9%	3	0%	0	0%	0	0%	0	3%	1	100%	35
Involvment of stakeholders and the general public	6%	2	17%	6	26%	9	26%	9	11%	4	3%	1	9%	3	3%	1	100%	35
Total	42%	189	24%	111	16%	74	11%	48	3%	15	1%	4	1%	6	2%	8	100%	455

	Total
Other - please describe	3

							Total	
Prioritise three of the following elements of QA that you find most important	**1.priority**		**2. priority**		**3. priority**		**Percent**	**Answers**
Guidance containing an overview and definitions of the different subtasks that a model job consist of	33%	6	44%	8	22%	4	51%	18
Detailed writtend guidelines in good modelling praxis	47%	8	47%	8	6%	1	49%	17
Competence and experience by the modeller	77%	23	13%	4	10%	3	86%	30
Model experience by the client	20%	3	40%	6	40%	6	43%	15
Formalised client-modeller dialog (e.g. at dedicated meetings)	45%	10	23%	5	32%	7	63%	22
External review several times during the model study	40%	6	27%	4	33%	5	43%	15
Model validations	58%	11	32%	6	11%	2	54%	19
Uncertainty assessments	56%	10	28%	5	17%	3	51%	18
Establishing of operational accuracy crietria	50%	8	38%	6	13%	2	46%	16
Documentation that makes it ppossible to understand the principles and assumptions in the model	46%	11	46%	11	8%	2	69%	24
Documentation that makes it possible to reproduce the model	33%	6	39%	7	28%	5	51%	18
Transparancy of the model	60%	9	27%	4	13%	2	43%	15
Involvment of stakeholders and the general public	8%	1	17%	2	75%	9	34%	12
Total	47%	112	32%	76	21%	51	100%	239

	Total
Other - please describe	1

													Total	
What is your experience regarding QA in the model jobs you have participated actively in?	**Always**		**Often**		**Some times**		**Rarely**		**Never**		**Don't know**		**Percent**	**Answers**
The study contains a plan for meetings desginated the discussion of sub results obtain during the model job	34%	12	37%	13	20%	7	9%	3	0%	0	0%	0	100%	35
There is a continusouly dialog between clients and consultants so possible problems that may have an effect on the final results can be discussed and decisions taken within a short timeframe	23%	8	49%	17	29%	10	0%	0	0%	0	0%	0	100%	35
An impartial external reviewer is associated to the project	3%	1	17%	6	37%	13	29%	10	14%	5	0%	0	100%	35
Total	20%	21	34%	36	29%	30	12%	13	5%	5	0%	0	100%	105

	Total
Please comment your answers	3

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements	**Completely agree 1**		**2**		**3**		**4**		**5**		**6**		**Completely disagree 7**		**don't know**		**Percent**	**Answers**
My experience is that the water managers put emphasis to QA in the terms of reference and when consultant is selected	0%	0	42%	14	18%	6	24%	8	3%	1	0%	0	3%	1	9%	3	100%	33
My experience is that the water managers are willing to pay extra for QA	0%	0	18%	6	15%	5	21%	7	18%	6	15%	5	3%	1	9%	3	100%	33
My experience is that the water managers put emphasise on QA during the supervision of a project	3%	1	18%	6	33%	11	24%	8	6%	2	0%	0	3%	1	12%	4	100%	33
My experience is that the modellers (consultants) have sufficient focus on QA	0%	0	15%	5	45%	15	18%	6	6%	2	6%	2	0%	0	9%	3	100%	33
My experience is that stakeholders (e.g. Water companies, NGOs) put emphasise on QA	0%	0	9%	3	21%	7	15%	5	9%	3	9%	3	3%	1	33%	11	100%	33
My evaluation is that increased focus on QA has contributed to improve the quality of a model study	39%	13	39%	13	6%	2	3%	1	0%	0	3%	1	0%	0	9%	3	100%	33
My evaluation is that the increased cost for formalised QA is well spend	45%	15	24%	8	12%	4	3%	1	3%	1	0%	0	0%	0	12%	4	100%	33
Total	13%	29	24%	55	22%	50	16%	36	6%	15	5%	11	2%	4	13%	31	100%	231

	Total
Please comment your your answers	3

													Total	
What is your experience with respect to needs and praxis in relation to modelling in your organisation?	**Always**		**Often**		**Some times**		**Rarely**		**Never**		**Don't know**		**Percent**	**Answers**
More people are often working on the same job at the same time and we have experienced the need for rigorius principles on how to handle data and model files	12%	4	36%	12	24%	8	9%	3	3%	1	15%	5	100%	33
If we need to work on an existing model it is not possible due to missing documentation	0%	0	21%	7	48%	16	15%	5	3%	1	12%	4	100%	33
Total	6%	4	29%	19	36%	24	12%	8	3%	2	14%	9	100%	66

	Total
Please comment your answers	2

																	Total	
To what extent have you developed procedures and tools for QA related to modelling in your organisation? Scale from 1 (Procedures/tools for all steps in modelling) to 7 (No procedures/tools developed)	1		2		3		4		5		6		7		Don't know		Percent	Answers
We have routines for documenting the technical work making it possible to reuse the model or hand the model over to another modeller	9%	3	15%	5	12%	4	18%	6	0%	0	9%	3	21%	7	15%	5	100%	33
We have developed routines or programmes for a standardised processing and QA of data used in the model, such that model input files always can be reconstructed	6%	2	18%	6	15%	5	9%	3	3%	1	6%	2	27%	9	15%	5	100%	33
Total	8%	5	17%	11	14%	9	14%	9	2%	1	8%	5	24%	16	15%	10	100%	66

	Total
We have developed other routines for QA than the one described above - please describe	1

					Total	
What is our knowledge of the sofwater progeamme MoST developed in the EU-project HarmoniQuA?	Yes		No		Percent	Answers
Have heard/read about it	82%	27	18%	6	100%	33
Have seen/tested/worked with the programme	42%	14	58%	19	100%	33
Total	62%	41	38%	25	100%	66

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements on the Guidance part of MoST?	Completely agree 1		2		3		4		5		6		Completely disagree 7		don't know		Percent	Answers
I like the ideas in MoST with respect to the design of good modelling praxis (protocol, pricnciples, etc.)	29%	7	29%	7	8%	2	4%	1	0%	0	0%	0	0%	0	29%	7	100%	24
I think the content of the guidance in MoST is good	8%	2	17%	4	25%	6	8%	2	8%	2	0%	0	0%	0	33%	8	100%	24
Total	19%	9	23%	11	17%	8	6%	3	4%	2	0%	0	0%	0	31%	15	100%	48

	Total
Have you suggestions to improvement of the content and the functionality of the guidance part in MoST?	4

																	Total	
On a scale from 1 (completely agree) to 7 (completely disagree), to which extend do you agree in the following statements on the reporting facility in MoST?	Completely agree 1		2		3		4		5		6		Completely disagree 7		don't know		Percent	Answers
I think the reporting facility is easy to understand	0%	0	4%	1	13%	3	13%	3	4%	1	8%	2	4%	1	54%	13	100%	24
I think MoST is easy to use during a project	0%	0	0%	0	4%	1	13%	3	13%	3	4%	1	21%	5	46%	11	100%	24
I think that most reporting facility was valuable to assure/improve the quality of the model job	0%	0	4%	1	8%	2	4%	1	8%	2	13%	3	8%	2	54%	13	100%	24
I thinkt that the reporting functionality fits well into the workflow of a model study	0%	0	4%	1	13%	3	4%	1	13%	3	4%	1	8%	2	54%	13	100%	24
Total	0%	0	3%	3	9%	9	8%	8	9%	9	7%	7	10%	10	52%	50	100%	96

	Total
Have you suggestions to improvement of the reporting functionality of MoST?	1

													Total	
How do you expect to use MoST in future projects?	Yes		Probably		Maybe		Not likely		Never		Don't know		Percent	Answers
Will you use MoST in its present form in furture projects?	0%	0	4%	1	26%	7	41%	11	4%	1	26%	7	100%	27
Will you consider using an improved version of MoST in a furture project?	22%	6	19%	5	30%	8	4%	1	0%	0	26%	7	100%	27
Total	11%	6	11%	6	28%	15	22%	12	2%	1	26%	14	100%	54

	Total
Please comment your answer	3

Answers by environmental centres

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn om, hvad der skal opnås gennem en kvalitetssikring?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Kvalitetssikring skal sikre, at modelrapporten fremstår uden fejl	45%	5	9%	1	27%	3	18%	2	0%	0	0%	0	0%	0	0%	0	100%	11
Kvalitetssikring skal sikre, at der ikke er fejl i modellen, f.eks. forkerte inputdata, eller fejl i opsætningen	91%	10	9%	1	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Kvalitetssikring skal sikre, at den færdige model er den bedst opnåelige med det foreliggende datamateriale	64%	7	27%	3	0%	0	0%	0	9%	1	0%	0	0%	0	0%	0	100%	11
Kvalitetssikring skal sikre, at der er opnået en gensidig forståelse mellem opdragsgiver og rådgiver om, hvad modellen hhv. kan og ikke kan anvendes til	45%	5	27%	3	0%	0	9%	1	0%	0	0%	0	18%	2	0%	0	100%	11
Total	61%	27	18%	8	7%	3	7%	3	2%	1	0%	0	5%	2	0%	0	100%	44

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg mener, at kvalitetssikring er et vigtigt element i en modelleringsopgave	82%	9	18%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Jeg mener, at en dokumenteret ekstraomkostning på grund af kvalitetssikring er acceptabel	45%	5	18%	2	0%	0	9%	1	0%	0	9%	1	18%	2	0%	0	100%	11
Jeg mener, at der er behov for nationale vejledninger for ensartet kvalitetssikring af modelleringsarbejdet	73%	8	18%	2	0%	0	9%	1	0%	0	0%	0	0%	0	0%	0	100%	11
Jeg synes, det ville være en god idé med et standardiseret softwareprogram til at understøtte kvalitetssikringen	36%	4	45%	5	9%	1	0%	0	0%	0	0%	0	0%	0	9%	1	100%	11
Total	59%	26	25%	11	2%	1	5%	2	0%	0	2%	1	5%	2	2%	1	100%	44

																	Total	
På en skala fra 1 (Meget væsentlig) til 7 (Ubetydelig), hvor væsentligt synes du følgende elementer er for at sikre god kvalitet af en modelleringsopgave?	**Meget væsentlig 1**		**2**		**3**		**4**		**5**		**6**		**Ubetydelig 7**		**ved ikke**		**Procent**	**Antal**
Guidance med oversigt og definition af de delopgaver en modellering består af	64%	7	18%	2	0%	0	18%	2	0%	0	0%	0	0%	0	0%	0	100%	11
Detaljerede skriftlige vejledninger i god modelleringspraksis	45%	5	18%	2	9%	1	18%	2	0%	0	0%	0	0%	0	9%	1	100%	11
Kompetence og erfaring hos modelløren	91%	10	9%	1	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Modelleringserfaring hos opdragsgiveren	18%	2	36%	4	36%	4	9%	1	0%	0	0%	0	0%	0	0%	0	100%	11
Formaliseret klient-modellør dialog (fx milepælsmøder)	64%	7	27%	3	9%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Eksternt review flere gange i projektforløbet	9%	1	27%	3	0%	0	55%	6	0%	0	0%	0	0%	0	9%	1	100%	11
Modelvalideringer	73%	8	18%	2	9%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Usikkerhedsvurderinger	73%	8	18%	2	9%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Opstilling af operationelle nøjagtighedskriterier	45%	5	18%	2	36%	4	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	82%	9	18%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Dokumentation der gør det muligt at reproducere modellen	82%	9	18%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Gennemskuelighed af modellen	55%	6	36%	4	9%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	11
Involvering af interessenter og offentlighed	0%	0	18%	2	36%	4	36%	4	0%	0	0%	0	9%	1	0%	0	100%	11
Total	54%	77	22%	31	12%	17	10%	15	0%	0	0%	0	1%	1	1%	2	100%	143

	Total
Andet - beskriv venligst i tekstfeltet	**1**

Prioritér tre af af nedenstående kvalitetssikringselementer som du finder vigtigst	1.prioritet		2. prioritet		3. prioritet		Total Procent	Total Antal
Guidance med oversigt og definition af de delopgaver en modellering består af	83%	5	17%	1	0%	0	55%	6
Detaljerede skriftlige vejledninger i god modelleringspraksis	83%	5	17%	1	0%	0	55%	6
Kompetence og erfaring hos modelløren	90%	9	10%	1	0%	0	91%	10
Modelleringserfaring hos opdragsgiveren	20%	1	40%	2	40%	2	45%	5
Formaliseret klient-modellør dialog (fx milepælsmøder)	100%	6	0%	0	0%	0	55%	6
Eksternt review flere gange i projektforløbet	25%	1	50%	2	25%	1	36%	4
Modelvalideringer	56%	5	33%	3	11%	1	82%	9
Usikkerhedsvurderinger	100%	5	0%	0	0%	0	45%	5
Opstilling af operationelle nøjagtighedskriterier	80%	4	20%	1	0%	0	45%	5
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	56%	5	33%	3	11%	1	82%	9
Dokumentation der gør det muligt at reproducere modellen	43%	3	29%	2	29%	2	64%	7
Gennemskuelighed af modellen	80%	4	20%	1	0%	0	45%	5
Involvering af interessenter og offentlighed	0%	0	50%	2	50%	2	36%	4
Total	65%	53	23%	19	11%	9	100%	81

	Total
Andet - beskriv venligst i tekstfeltet	0

Hvad er dine erfaringer vedrørende kvalitetssikring i de modelopgaver du har deltaget aktivt i?	Altid		Ofte		En gang imellem		Sjældent		Aldrig		Ved ikke		Total Procent	Total Antal
Der er en fast plan for hvornår delresultater skal diskuteres (f.eks. Milepælsmøder)	45%	5	36%	4	18%	2	0%	0	0%	0	0%	0	100%	11
Der er løbende kontakt mellem opdragsgiver og rådgiver, så evt. problemer der kan have effekt på det endelige resultat hurtigt kan diskuteres og der kan tages en beslutning	27%	3	55%	6	18%	2	0%	0	0%	0	0%	0	100%	11
Der er en uvildig ekstern reviewer tilknyttet projektet	0%	0	18%	2	27%	3	36%	4	18%	2	0%	0	100%	11
Total	24%	8	36%	12	21%	7	12%	4	6%	2	0%	0	100%	33

	Total
Kommentér gerne din besvarelse af ovenstående	0

På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn	Helt enig 1		2		3		4		5		6		Helt uenig 7		ved ikke		Total Procent	Total Antal
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring i udbudsbetingelser og ved udvælgelse af rådgiver	0%	0	67%	6	33%	3	0%	0	0%	0	0%	0	0%	0	0%	0	100%	9
Jeg oplever, at opdragsgiveren er villig til at betale ekstra for kvalitetssikring	0%	0	67%	6	22%	2	0%	0	0%	0	11%	1	0%	0	0%	0	100%	9
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring under tilsyn af projektet	11%	1	22%	2	44%	4	22%	2	0%	0	0%	0	0%	0	0%	0	100%	9
Jeg oplever, at modellørerne (rådgiverne) har tilstrækkelig fokus på kvalitetssikring	0%	0	11%	1	44%	4	44%	4	0%	0	0%	0	0%	0	0%	0	100%	9
Jeg oplever, at interessenterne (fx vandselskaber, grønne organisationer, landbruget) lægger stor vægt på kvalitetssikring	0%	0	22%	2	11%	1	11%	1	0%	0	11%	1	0%	0	44%	4	100%	9
Jeg vurderer, at øget fokus på kvalitetssikring har været medvirkende til at forbedre kvaliteten af en modelopgave	44%	4	33%	3	0%	0	11%	1	0%	0	0%	0	0%	0	11%	1	100%	9
Min vurdering er, at den øgede omkostning forbundet ved formaliseret kvalitetssikring er givet godt ud	44%	4	33%	3	22%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	9
Total	14%	9	37%	23	25%	16	13%	8	0%	0	3%	2	0%	0	8%	5	100%	63

	Total
Kommentér gerne din besvarelse af ovenstående udsagn	0

Hvad er dine erfaringer mht. behov og praksis i forbindelse med modellering indenfor den organisation du er ansat i?	Altid		Ofte		En gang imellem		Sjældent		Aldrig		Ved ikke		Total Procent	Total Antal
Vi er ofte flere der arbejder samtidigt på én opgave, og har oplevet behov for klare retningslinier mht. håndtering af data og modelfiler	0%	0	33%	3	33%	3	11%	1	11%	1	11%	1	100%	9
Hvis vi har behov for at arbejde videre med en eksisterende model kan det ikke lade sig gøre pga. manglende dokumentation	0%	0	33%	3	56%	5	0%	0	0%	0	11%	1	100%	9
Total	0%	0	33%	6	44%	8	6%	1	6%	1	11%	2	100%	18

	Total
Kommentér gerne din besvarelse	0

I hvilken udstrækning har I indenfor din organisation udviklet procedurer og værktøjer for kvalitetsikring i forbindelse med modellering? Skala fra 1 (Procedurer/værktøjer til alle led i modelleringen) til 7 (Ingen procedure/værktøjer udviklet)	1		2		3		4		5		6		7		ved ikke		Total Procent	Total Antal
Vi har rutiner for dokumentation af det tekniske arbejde, der gør det muligt at genoptage modellen eller overdrage denne til en anden modellør	0%	0	0%	0	11%	1	11%	1	0%	0	22%	2	33%	3	22%	2	100%	9
Vi har udviklet rutiner eller programmer for en standardiseret processesering og kvalitetssikring af data, der indgår i modellen så inputfiler altid kan genskabes	0%	0	0%	0	11%	1	11%	1	0%	0	22%	2	33%	3	22%	2	100%	9
Total	0%	0	0%	0	11%	2	11%	2	0%	0	22%	4	33%	6	22%	4	100%	18

	Total
Vi har udviklet andre end ovenstående rutiner til kvalitetssikring - beskriv venligst i kommetarfeltet	0

Hvad er dit kendskab til softwareprogrammet MoST, som udviklet i EU-projektet HarmoniQuA?	Ja		Nej		Total Procent	Total Antal
Har hørt / læst om det	100%	9	0%	0	100%	9
Har kigget /afprøvet /arbejdet med det	44%	4	56%	5	100%	9
Total	72%	13	28%	5	100%	18

På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedestående udsagn om Guidance delen i MoST?	Helt enig 1		2		3		4		5		6		Helt uenig 7		ved ikke		Total Procent	Total Antal
Jeg synes godt om de ideer der ligger i MoST mht design af god modelleringspraksis (protokol, principper, mv)	25%	2	50%	4	13%	1	0%	0	0%	0	0%	0	0%	0	13%	1	100%	8
Jeg synes, at indholdet af den guidance der er indbygget i MoST er god	13%	1	38%	3	13%	1	0%	0	13%	1	0%	0	0%	0	25%	2	100%	8
Total	19%	3	44%	7	13%	2	0%	0	6%	1	0%	0	0%	0	19%	3	100%	16

	Total
Har du forslag til forbedringer af indholdet og funktionaliteten i forbindelse med guidiance-delen i MoST?	1

På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedenstående udsagn mht. projektrapporteringsfunktionen i MoST?	Helt enig 1		2		3		4		5		6		Helt uenig 7		ved ikke		Total Procent	Total Antal
Jeg synes, at projektrapporteringsfunktionen i MoST er nem at forstå	0%	0	13%	1	25%	2	0%	0	13%	1	13%	1	0%	0	38%	3	100%	8
Jeg synes, at MoST er nem at anvende sammen med et projekt	0%	0	0%	0	13%	1	13%	1	25%	2	13%	1	0%	0	38%	3	100%	8
Jeg synes, at MoST rapportering var nytting til at sikre/forbedre kvaliteten af modeleringsarbejdet	0%	0	13%	1	13%	1	13%	1	13%	1	13%	1	0%	0	38%	3	100%	8
Jeg synes, at funktionaliteten i MoST passer godt med arbejdsgangen i et projekt	0%	0	13%	1	25%	2	13%	1	13%	1	0%	0	0%	0	38%	3	100%	8
Total	0%	0	9%	3	19%	6	9%	3	16%	5	9%	3	0%	0	38%	12	100%	32

	Total
Har du forslag til forbedringer af funktionaliteten i forbindelse med projektrapporteringsdelen i MoST?	0

Hvordan tror du, at du vil anvende MoST fremover?	Ja		Sandsynligvis		Måske		Næppe		Aldrig		Ved ikke		Total Procent	Total Antal
Vil du bruge MoST i sin nuværende form i et fremtidigt projekt?	0%	0	13%	1	38%	3	25%	2	0%	0	25%	2	100%	8
Vil du overvje at bruge en forbedret version af MoST i et fremtidigt projekt?	38%	3	13%	1	25%	2	0%	0	0%	0	25%	2	100%	8
Total	19%	3	13%	2	31%	5	13%	2	0%	0	25%	4	100%	16

	Total
Kommentér gerne din besvarelse.	0

Answers by consultants

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn om, hvad der skal opnås gennem en kvalitetssikring?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Kvalitetssikring skal sikre, at modelrapporten fremstår uden fejl	38%	5	23%	3	15%	2	8%	1	0%	0	0%	0	15%	2	0%	0	100%	13
Kvalitetssikring skal sikre, at der ikke er fejl i modellen, f.eks. forkerte inputdata, eller fejl i opsætningen	62%	8	38%	5	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	13
Kvalitetssikring skal sikre, at den færdige model er den bedst opnåelige med det foreliggende datamateriale	31%	4	62%	8	0%	0	8%	1	0%	0	0%	0	0%	0	0%	0	100%	13
Kvalitetssikring skal sikre, at der er opnået en gensidig forståelse mellem opdragsgiver og rådgiver om, hvad modellen hhv. kan og ikke kan anvendes til	46%	6	23%	3	31%	4	0%	0	0%	0	0%	0	0%	0	0%	0	100%	13
Total	44%	23	37%	19	12%	6	4%	2	0%	0	0%	0	4%	2	0%	0	100%	52

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg mener, at kvalitetssikring er et vigtigt element i en modelleringsopgave	77%	10	23%	3	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	13
Jeg mener, at en dokumenteret ekstraomkostning på grund af kvalitetssikring er acceptabel	62%	8	23%	3	8%	1	0%	0	0%	0	0%	0	0%	0	8%	1	100%	13
Jeg mener, at der er behov for nationale vejledninger for ensartet kvalitetssikring af modelleringsarbejdet	23%	3	38%	5	8%	1	15%	2	15%	2	0%	0	0%	0	0%	0	100%	13
Jeg synes, det ville være en god idé med et standardiseret softwareprogram til at understøtte kvalitetssikringen	0%	0	15%	2	15%	2	15%	2	46%	6	8%	1	0%	0	0%	0	100%	13
Total	40%	21	25%	13	8%	4	8%	4	15%	8	2%	1	0%	0	2%	1	100%	52

																	Total	
På en skala fra 1 (Meget væsentlig) til 7 (Ubetydelig), hvor væsentligt synes du følgende elementer er for at sikre god kvalitet af en modelleringsopgave?	**Meget væsentlig 1**		**2**		**3**		**4**		**5**		**6**		**Ubetydelig 7**		**ved ikke**		**Procent**	**Antal**
Guidance med oversigt og definition af de delopgaver en modellering består af	15%	2	15%	2	46%	6	8%	1	8%	1	0%	0	0%	0	8%	1	100%	13
Detaljerede skriftlige vejledninger i god modelleringspraksis	8%	1	46%	6	15%	2	23%	3	0%	0	0%	0	0%	0	8%	1	100%	13
Kompetence og erfaring hos modelløren	62%	8	23%	3	15%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	13
Modelleringserfaring hos opdragsgiveren	8%	1	38%	5	31%	4	8%	1	8%	1	0%	0	8%	1	0%	0	100%	13
Formaliseret klient-modellør dialog (fx milepælsmøder)	23%	3	38%	5	23%	3	8%	1	0%	0	0%	0	8%	1	0%	0	100%	13
Eksternt review flere gange i projektforløbet	8%	1	31%	4	8%	1	23%	3	8%	1	15%	2	0%	0	8%	1	100%	13
Modelvalideringer	38%	5	31%	4	8%	1	15%	2	8%	1	0%	0	0%	0	0%	0	100%	13
Usikkerhedsvurderinger	46%	6	23%	3	8%	1	15%	2	8%	1	0%	0	0%	0	0%	0	100%	13
Opstilling af operationelle nøjagtighedskriterier	8%	1	46%	6	23%	3	15%	2	8%	1	0%	0	0%	0	0%	0	100%	13
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	85%	11	15%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	13
Dokumentation der gør det muligt at reproducere modellen	38%	5	23%	3	15%	2	8%	1	8%	1	0%	0	0%	0	8%	1	100%	13
Gennemskuelighed af modellen	46%	6	23%	3	8%	1	15%	2	0%	0	0%	0	0%	0	8%	1	100%	13
Involvering af interessenter og offentlighed	15%	2	15%	2	15%	2	23%	3	8%	1	8%	1	8%	1	8%	1	100%	13
Total	31%	52	28%	48	17%	28	12%	21	5%	8	2%	3	2%	3	4%	6	100%	169

	Total
Andet - beskriv venligst i tekstfeltet	**1**

							Total	
Prioritér tre af af nedenstående kvalitetssikringselementer som du finder vigtigst	**1.prioritet**		**2. prioritet**		**3. prioritet**		**Procent**	**Antal**
Guidance med oversigt og definition af de delopgaver en modellering består af	14%	1	57%	4	29%	2	54%	7
Detaljerede skriftlige vejledninger i god modelleringspraksis	17%	1	67%	4	17%	1	46%	6
Kompetence og erfaring hos modelløren	64%	7	18%	2	18%	2	85%	11
Modelleringserfaring hos opdragsgiveren	0%	0	33%	2	67%	4	46%	6
Formaliseret klient-modellør dialog (fx milepælsmøder)	22%	2	22%	2	56%	5	69%	9
Eksternt review flere gange i projektforløbet	33%	2	17%	1	50%	3	46%	6
Modelvalideringer	60%	3	40%	2	0%	0	38%	5
Usikkerhedsvurderinger	43%	3	29%	2	29%	2	54%	7
Opstilling af operationelle nøjagtighedskriterier	14%	1	57%	4	29%	2	54%	7
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	63%	5	38%	3	0%	0	62%	8
Dokumentation der gør det muligt at reproducere modellen	20%	1	60%	3	20%	1	38%	5
Gennemskuelighed af modellen	50%	2	50%	2	0%	0	31%	4
Involvering af interessenter og offentlighed	25%	1	0%	0	75%	3	31%	4
Total	34%	29	36%	31	29%	25	100%	85

	Total
Andet - beskriv venligst i tekstfeltet	**0**

													Total	
Hvad er dine erfaringer vedrørende kvalitetssikring i de modelopgaver du har deltaget aktivt i?	**Altid**		**Ofte**		**En gang imellem**		**Sjældent**		**Aldrig**		**Ved ikke**		**Procent**	**Antal**
Der er en fast plan for hvornår delresultater skal diskuteres (f.eks. Milepælsmøder)	31%	4	31%	4	23%	3	15%	2	0%	0	0%	0	100%	13
Der er løbende kontakt mellem opdragsgiver og rådgiver, så evt. problemer der kan have effekt på det endelige resultat hurtigt kan diskuteres og der kan tages en beslutning	23%	3	54%	7	23%	3	0%	0	0%	0	0%	0	100%	13
Der er en uvildig ekstern reviewer tilknyttet projektet	8%	1	0%	0	46%	6	23%	3	23%	3	0%	0	100%	13
Total	21%	8	28%	11	31%	12	13%	5	8%	3	0%	0	100%	39

	Total
Kommentér gerne din besvarelse af ovenstående	**1**

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring i udbudsbetingelser og ved udvælgelse af rådgiver	0%	0	46%	6	15%	2	31%	4	0%	0	0%	0	8%	1	0%	0	100%	13
Jeg oplever, at opdragsgiveren er villig til at betale ekstra for kvalitetssikring	0%	0	0%	0	15%	2	23%	3	38%	5	15%	2	8%	1	0%	0	100%	13
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring under tilsyn af projektet	0%	0	15%	2	38%	5	23%	3	8%	1	0%	0	8%	1	8%	1	100%	13
Jeg oplever, at modellørerne (rådgiverne) har tilstrækkelig fokus på kvalitetssikring	0%	0	31%	4	62%	8	0%	0	0%	0	0%	0	0%	0	8%	1	100%	13
Jeg oplever, at interessenterne (fx vandselskaber, grønne organisationer, landbruget) lægger stor vægt på kvalitetssikring	0%	0	8%	1	23%	3	8%	1	23%	3	8%	1	8%	1	23%	3	100%	13
Jeg vurderer, at øget fokus på kvalitetssikring har været medvirkende til at forbedre kvaliteten af en modelopgave	46%	6	46%	6	0%	0	0%	0	0%	0	0%	0	0%	0	8%	1	100%	13
Min vurdering er, at den øgede omkostning forbundet ved formaliseret kvalitetssikring er givet godt ud	46%	6	31%	4	8%	1	0%	0	0%	0	0%	0	0%	0	15%	2	100%	13
Total	13%	12	25%	23	23%	21	12%	11	10%	9	3%	3	4%	4	9%	8	100%	91

	Total
Kommentér gerne din besvarelse af ovenstående udsagn	**2**

													Total	
Hvad er dine erfaringer mht. behov og praksis i forbindelse med modellering indenfor den organisation du er ansat i?	**Altid**		**Ofte**		**En gang imellem**		**Sjældent**		**Aldrig**		**Ved ikke**		**Procent**	**Antal**
Vi er ofte flere der arbejder samtidigt på én opgave, og har oplevet behov for klare retningslinier mht. håndtering af data og modelfiler	8%	1	62%	8	15%	2	8%	1	0%	0	8%	1	100%	13
Hvis vi har behov for at arbejde videre med en eksisterende model kan det ikke lade sig gøre pga. manglende dokumentation	0%	0	15%	2	62%	8	8%	1	8%	1	8%	1	100%	13
Total	4%	1	38%	10	38%	10	8%	2	4%	1	8%	2	100%	26

	Total
Kommentér gerne din besvarelse	**2**

																	Total	
I hvilken udstrækning har I indenfor din organisation udviklet procedurer og værktøjer for kvalitetsikring i forbindelse med modellering? Skala fra 1 (Procedurer/værktøjer til alle led i modelleringen) til 7 (Ingen procedure/værktøjer udviklet)	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**ved ikke**		**Procent**	**Antal**
Vi har rutiner for dokumentation af det tekniske arbejde, der gør det muligt at genoptage modellen eller overdrage denne til en anden modellør	15%	2	38%	5	15%	2	23%	3	0%	0	0%	0	0%	0	8%	1	100%	13
Vi har udviklet rutiner eller programmer for en standardiseret processesering og kvalitetssikring af data, der indgår i modellen så inputfiler altid kan genskabes	8%	1	38%	5	31%	4	8%	1	8%	1	0%	0	0%	0	8%	1	100%	13
Total	12%	3	38%	10	23%	6	15%	4	4%	1	0%	0	0%	0	8%	2	100%	26

	Total
Vi har udviklet andre end ovenstående rutiner til kvalitetssikring - beskriv venligst i kommetarfeltet	**1**

					Total	
Hvad er dit kendskab til softwareprogrammet MoST, som udviklet i EU-projektet HarmoniQuA?	**Ja**		**Nej**		**Procent**	**Antal**
Har hørt / læst om det	77%	10	23%	3	100%	13
Har kigget /afprøvet /arbejdet med det	46%	6	54%	7	100%	13
Total	62%	16	38%	10	100%	26

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedestående udsagn om Guidance delen i MoST?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg synes godt om de ideer der ligger i MoST mht design af god modelleringspraksis (protokol, principper, mv)	18%	2	27%	3	0%	0	9%	1	0%	0	0%	0	0%	0	45%	5	100%	11
Jeg synes, at indholdet af den guidance der er indbygget i MoST er god	9%	1	0%	0	27%	3	9%	1	9%	1	0%	0	0%	0	45%	5	100%	11
Total	14%	3	14%	3	14%	3	9%	2	5%	1	0%	0	0%	0	45%	10	100%	22

	Total
Har du forslag til forbedringer af indholdet og funktionaliteten i forbindelse med guidiance-delen i MoST?	**2**

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedenstående udsagn mht. projektrapporteringsfunktionen i MoST?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg synes, at projektrapporteringsfunktionen i MoST er nem at forstå	0%	0	0%	0	0%	0	18%	2	0%	0	0%	0	9%	1	73%	8	100%	11
Jeg synes, at MoST er nem at anvende sammen med et projekt	0%	0	0%	0	0%	0	9%	1	9%	1	0%	0	36%	4	45%	5	100%	11
Jeg synes, at MoST rapportering var nytting til at sikre/forbedre kvaliteten af modeleringsarbejdet	0%	0	0%	0	9%	1	0%	0	0%	0	18%	2	9%	1	64%	7	100%	11
Jeg synes, at funktionaliteten i MoST passer godt med arbejdsgangen i et projekt	0%	0	0%	0	9%	1	0%	0	9%	1	0%	0	18%	2	64%	7	100%	11
Total	0%	0	0%	0	5%	2	7%	3	5%	2	5%	2	18%	8	61%	27	100%	44

	Total
Har du forslag til forbedringer af funktionaliteten i forbindelse med projektrapporteringsdelen i MoST?	**1**

													Total	
Hvordan tror du, at du vil anvende MoST fremover?	**Ja**		**Sandsynligvis**		**Måske**		**Næppe**		**Aldrig**		**ved ikke**		**Procent**	**Antal**
Vil du bruge MoST i sin nuværende form i et fremtidigt projekt?	0%	0	0%	0	8%	1	46%	6	8%	1	38%	5	100%	13
Vil du overvje at bruge en forbedret version af MoST i et fremtidigt projekt?	8%	1	23%	3	23%	3	8%	1	0%	0	38%	5	100%	13
Total	4%	1	12%	3	15%	4	27%	7	4%	1	38%	10	100%	26

	Total
Kommentér gerne din besvarelse.	**2**

Answers by water companies

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn om, hvad der skal opnås gennem en kvalitetssikring?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Kvalitetssikring skal sikre, at modelrapporten fremstår uden fejl	0%	0	67%	2	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Kvalitetssikring skal sikre, at der ikke er fejl i modellen, f.eks. forkerte inputdata, eller fejl i opsætningen	67%	2	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Kvalitetssikring skal sikre, at den færdige model er den bedst opnåelige med det foreliggende datamateriale	33%	1	33%	1	0%	0	0%	0	33%	1	0%	0	0%	0	0%	0	100%	3
Kvalitetssikring skal sikre, at der er opnået en gensidig forståelse mellem opdragsgiver og rådgiver om, hvad modellen hhv. kan og ikke kan anvendes til	33%	1	0%	0	33%	1	0%	0	33%	1	0%	0	0%	0	0%	0	100%	3
Total	33%	4	33%	4	17%	2	0%	0	17%	2	0%	0	0%	0	0%	0	100%	12

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg mener, at kvalitetssikring er et vigtigt element i en modelleringsopgave	67%	2	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Jeg mener, at en dokumenteret ekstraomkostning på grund af kvalitetssikring er acceptabel	0%	0	33%	1	33%	1	33%	1	0%	0	0%	0	0%	0	0%	0	100%	3
Jeg mener, at der er behov for nationale vejledninger for ensartet kvalitetssikring af modelleringsarbejdet	33%	1	0%	0	33%	1	33%	1	0%	0	0%	0	0%	0	0%	0	100%	3
Jeg synes, det ville være en god idé med et standardiseret softwareprogram til at understøtte kvalitetssikringen	0%	0	0%	0	67%	2	33%	1	0%	0	0%	0	0%	0	0%	0	100%	3
Total	25%	3	17%	2	33%	4	25%	3	0%	0	0%	0	0%	0	0%	0	100%	12

																	Total	
På en skala fra 1 (Meget væsentlig) til 7 (Ubetydelig), hvor væsentligt synes du følgende elementer er for at sikre god kvalitet af en modelleringsopgave?	**Meget væsentlig 1**		**2**		**3**		**4**		**5**		**6**		**Ubetydelig 7**		**ved ikke**		**Procent**	**Antal**
Guidance med oversigt og definition af de delopgaver en modellering består af	0%	0	0%	0	33%	1	67%	2	0%	0	0%	0	0%	0	0%	0	100%	3
Detaljerede skriftlige vejledninger i god modelleringspraksis	0%	0	0%	0	33%	1	67%	2	0%	0	0%	0	0%	0	0%	0	100%	3
Kompetence og erfaring hos modelløren	100%	3	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Modelleringserfaring hos opdragsgiveren	33%	1	0%	0	67%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Formaliseret klient-modellør dialog (fx milepælsmøder)	67%	2	0%	0	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Eksternt review flere gange i projektforløbet	0%	0	0%	0	67%	2	0%	0	33%	1	0%	0	0%	0	0%	0	100%	3
Modelvalideringer	33%	1	33%	1	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Usikkerhedsvurderinger	0%	0	67%	2	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Opstilling af operationelle nøjagtighedskriterier	0%	0	0%	0	100%	3	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	0%	0	33%	1	67%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Dokumentation der gør det muligt at reproducere modellen	0%	0	33%	1	33%	1	33%	1	0%	0	0%	0	0%	0	0%	0	100%	3
Gennemskuelighed af modellen	33%	1	33%	1	33%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3
Involvering af interessenter og offentlighed	0%	0	0%	0	0%	0	33%	1	67%	2	0%	0	0%	0	0%	0	100%	3
Total	21%	8	15%	6	41%	16	15%	6	8%	3	0%	0	0%	0	0%	0	100%	39

	Total
Andet - beskriv venligst i tekstfeltet	**1**

Prioritér tre af af nedenstående kvalitetssikringselementer som du finder vigtigst	1.prioritet		2. prioritet		3. prioritet		Total Procent	Total Antal
Guidance med oversigt og definition af de delopgaver en modellering består af	0%	0	50%	1	50%	1	67%	2
Detaljerede skriftlige vejledninger i god modelleringspraksis	0%	0	100%	2	0%	0	67%	2
Kompetence og erfaring hos modelløren	100%	3	0%	0	0%	0	100%	3
Modelleringserfaring hos opdragsgiveren	50%	1	50%	1	0%	0	67%	2
Formaliseret klient-modellør dialog (fx milepælsmøder)	0%	0	67%	2	33%	1	100%	3
Eksternt review flere gange i projektforløbet	0%	0	50%	1	50%	1	67%	2
Modelvalideringer	50%	1	0%	0	50%	1	67%	2
Usikkerhedsvurderinger	100%	2	0%	0	0%	0	67%	2
Opstilling af operationelle nøjagtighedskriterier	50%	1	50%	1	0%	0	67%	2
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	33%	1	67%	2	0%	0	100%	3
Dokumentation der gør det muligt at reproducere modellen	0%	0	50%	1	50%	1	67%	2
Gennemskuelighed af modellen	100%	2	0%	0	0%	0	67%	2
Involvering af interessenter og offentlighed	0%	0	0%	0	100%	2	67%	2
Total	38%	11	38%	11	24%	7	100%	29

	Total
Andet - beskriv venligst i tekstfeltet	1

Hvad er dine erfaringer vedrørende kvalitetssikring i de modelopgaver du har deltaget aktivt i?	Altid		Ofte		En gang imellem		Sjældent		Aldrig		Ved ikke		Total Procent	Total Antal
Der er en fast plan for hvornår delresultater skal diskuteres (f.eks. Milepælsmøder)	33%	1	33%	1	0%	0	33%	1	0%	0	0%	0	100%	3
Der er løbende kontakt mellem opdragsgiver og rådgiver, så evt. problemer der kan have effekt på det endelige resultat hurtigt kan diskuteres og der kan tages en beslutning	0%	0	33%	1	67%	2	0%	0	0%	0	0%	0	100%	3
Der er en uvildig ekstern reviewer tilknyttet projektet	0%	0	0%	0	0%	0	100%	3	0%	0	0%	0	100%	3
Total	11%	1	22%	2	22%	2	44%	4	0%	0	0%	0	100%	9

	Total
Kommentér gerne din besvarelse af ovenstående	1

På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn	Helt enig 1		2		3		4		5		6		Helt uenig 7		ved ikke		Total Procent	Total Antal
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring i udbudsbetingelser og ved udvælgelse af rådgiver	0%	0	0%	0	33%	1	33%	1	0%	0	0%	0	0%	0	33%	1	100%	3
Jeg oplever, at opdragsgiveren er villig til at betale ekstra for kvalitetssikring	0%	0	0%	0	0%	0	33%	1	0%	0	67%	2	0%	0	0%	0	100%	3
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring under tilsyn af projektet	0%	0	0%	0	0%	0	33%	1	33%	1	0%	0	0%	0	33%	1	100%	3
Jeg oplever, at modellørerne (rådgiverne) har tilstrækkelig fokus på kvalitetssikring	0%	0	0%	0	0%	0	0%	0	33%	1	33%	1	0%	0	33%	1	100%	3
Jeg oplever, at interessenterne (fx vandselskaber, grønne organisationer, landbruget) lægger stor vægt på kvalitetssikring	0%	0	0%	0	0%	0	100%	3	0%	0	0%	0	0%	0	0%	0	100%	3
Jeg vurderer, at øget fokus på kvalitetssikring har været medvirkende til at forbedre kvaliteten af en modelopgave	33%	1	33%	1	0%	0	0%	0	0%	0	33%	1	0%	0	0%	0	100%	3
Min vurdering er, at den øgede omkostning forbundet ved formaliseret kvalitetssikring er givet godt ud	0%	0	0%	0	33%	1	33%	1	33%	1	0%	0	0%	0	0%	0	100%	3
Total	5%	1	5%	1	10%	2	33%	7	14%	3	19%	4	0%	0	14%	3	100%	21

	Total
Kommentér gerne din besvarelse af ovenstående udsagn	1

Hvad er dine erfaringer mht. behov og praksis i forbindelse med modellering indenfor den organisation du er ansat i?	Altid		Ofte		En gang imellem		Sjældent		Aldrig		Ved ikke		Total Procent	Total Antal
Vi er ofte flere der arbejder samtidigt på én opgave, og har oplevet behov for klare retningslinier mht. håndtering af data og modelfiler	0%	0	0%	0	33%	1	33%	1	0%	0	33%	1	100%	3
Hvis vi har behov for at arbejde videre med en eksisterende model kan det ikke lade sig gøre pga. manglende dokumentation	0%	0	0%	0	67%	2	33%	1	0%	0	0%	0	100%	3
Total	0%	0	0%	0	50%	3	33%	2	0%	0	17%	1	100%	6

	Total
Kommentér gerne din besvarelse	0

																	Total	
I hvilken udstrækning har I indenfor din organisation udviklet procedurer og værktøjer for kvalitetsikring i forbindelse med modellering? Skala fra 1 (Procedurer/værktøjer til alle led i modelleringen) til 7 (Ingen procedure/værktøjer udviklet)	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**ved ikke**		**Procent**	**Antal**
Vi har rutiner for dokumentation af det tekniske arbejde, der gør det muligt at genoptage modellen eller overdrage denne til en anden modellør	0%	0	0%	0	33%	1	0%	0	0%	0	0%	0	67%	2	0%	0	100%	3
Vi har udviklet rutiner eller programmer for en standardiseret processesering og kvalitetssikring af data, der indgår i modellen så inputfiler altid kan genskabes	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3	0%	0	100%	3
Total	0%	0	0%	0	17%	1	0%	0	0%	0	0%	0	83%	5	0%	0	100%	6

	Total
Vi har udviklet andre end ovenstående rutiner til kvalitetssikring - beskriv venligst i kommetarfeltet	**0**

					Total	
Hvad er dit kendskab til softwareprogrammet MoST, som udviklet i EU-projektet HarmoniQuA?	**Ja**		**Nej**		**Procent**	**Antal**
Har hørt / læst om det	67%	2	33%	1	100%	3
Har kigget /afprøvet /arbejdet med det	33%	1	67%	2	100%	3
Total	50%	3	50%	3	100%	6

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedestående udsagn om Guidance delen i MoST?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg synes godt om de ideer der ligger i MoST mht design af god modelleringspraksis (protokol, principper, mv)	0%	0	0%	0	100%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	1
Jeg synes, at indholdet af den guidance der er indbygget i MoST er god	0%	0	0%	0	100%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	1
Total	0%	0	0%	0	100%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	2

	Total
Har du forslag til forbedringer af indholdet og funktionaliteten i forbindelse med guidiance-delen i MoST?	**1**

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedenstående udsagn mht. projektrapporteringsfunktionen i MoST?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg synes, at projektrapporteringsfunktionen i MoST er nem at forstå	0%	0	0%	0	100%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	1
Jeg synes, at MoST er nem at anvende sammen med et projekt	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	1	100%	1
Jeg synes, at MoST rapportering var nytting til at sikre/forbedre kvaliteten af modeleringsarbejdet	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	1	100%	1
Jeg synes, at funktionaliteten i MoST passer godt med arbejdsgangen i et projekt	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	1	100%	1
Total	0%	0	0%	0	25%	1	0%	0	0%	0	0%	0	0%	0	75%	3	100%	4

	Total
Har du forslag til forbedringer af funktionaliteten i forbindelse med projektrapporteringsdelen i MoST?	**0**

													Total	
Hvordan tror du, at du vil anvende MoST fremover?	**Ja**		**Sandsynligvis**		**Måske**		**Næppe**		**Aldrig**		**ved ikke**		**Procent**	**Antal**
Vil du bruge MoST i sin nuværende form i et fremtidigt projekt?	0%	0	0%	0	0%	0	100%	1	0%	0	0%	0	100%	1
Vil du overvje at bruge en forbedret version af MoST i et fremtidigt projekt?	0%	0	0%	0	100%	1	0%	0	0%	0	0%	0	100%	1
Total	0%	0	0%	0	50%	1	50%	1	0%	0	0%	0	100%	2

	Total
Kommentér gerne din besvarelse.	**1**

Answers by research institutions

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn om, hvad der skal opnås gennem en kvalitetssikring?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Kvalitetssikring skal sikre, at modelrapporten fremstår uden fejl	50%	4	25%	2	13%	1	13%	1	0%	0	0%	0	0%	0	0%	0	100%	8
Kvalitetssikring skal sikre, at der ikke er fejl i modellen, f.eks. forkerte inputdata, eller fejl i opsætningen	75%	6	25%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Kvalitetssikring skal sikre, at den færdige model er den bedst opnåelige med det foreliggende datamateriale	63%	5	13%	1	0%	0	0%	0	13%	1	0%	0	13%	1	0%	0	100%	8
Kvalitetssikring skal sikre, at der er opnået en gensidig forståelse mellem opdragsgiver og rådgiver om, hvad modellen hhv. kan og ikke kan anvendes til	63%	5	13%	1	13%	1	0%	0	0%	0	0%	0	13%	1	0%	0	100%	8
Total	63%	20	19%	6	6%	2	3%	1	3%	1	0%	0	6%	2	0%	0	100%	32

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn?	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg mener, at kvalitetssikring er et vigtigt element i en modelleringsopgave	75%	6	25%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Jeg mener, at en dokumenteret ekstraomkostning på grund af kvalitetssikring er acceptabel	63%	5	38%	3	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Jeg mener, at der er behov for nationale vejledninger for ensartet kvalitetssikring af modelleringsarbejdet	50%	4	25%	2	13%	1	0%	0	13%	1	0%	0	0%	0	0%	0	100%	8
Jeg synes, det ville være en god idé med et standardiseret softwareprogram til at understøtte kvalitetssikringen	50%	4	0%	0	38%	3	0%	0	13%	1	0%	0	0%	0	0%	0	100%	8
Total	59%	19	22%	7	13%	4	0%	0	6%	2	0%	0	0%	0	0%	0	100%	32

																	Total	
På en skala fra 1 (Meget væsentlig) til 7 (Ubetydelig), hvor væsentligt synes du følgende elementer er for at sikre god kvalitet af en modelleringsopgave?	**Meget væsentlig 1**		**2**		**3**		**4**		**5**		**6**		**Ubetydelig 7**		**ved ikke**		**Procent**	**Antal**
Guidance med oversigt og definition af de delopgaver en modellering består af	38%	3	38%	3	25%	2	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Detaljerede skriftlige vejledninger i god modelleringspraksis	38%	3	38%	3	13%	1	13%	1	0%	0	0%	0	0%	0	0%	0	100%	8
Kompetence og erfaring hos modelløren	100%	8	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Modelleringserfaring hos opdragsgiveren	25%	2	13%	1	50%	4	13%	1	0%	0	0%	0	0%	0	0%	0	100%	8
Formaliseret klient-modellør dialog (fx milepælsmøder)	63%	5	38%	3	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Eksternt review flere gange i projektforløbet	63%	5	0%	0	13%	1	13%	1	13%	1	0%	0	0%	0	0%	0	100%	8
Modelvalideringer	50%	4	38%	3	0%	0	0%	0	0%	0	0%	0	13%	1	0%	0	100%	8
Usikkerhedsvurderinger	75%	6	13%	1	0%	0	0%	0	0%	0	13%	1	0%	0	0%	0	100%	8
Opstilling af operationelle nøjagtighedskriterier	50%	4	13%	1	13%	1	0%	0	25%	2	0%	0	0%	0	0%	0	100%	8
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	63%	5	25%	2	13%	1	0%	0	0%	0	0%	0	0%	0	0%	0	100%	8
Dokumentation der gør det muligt at reproducere modellen	38%	3	50%	4	0%	0	13%	1	0%	0	0%	0	0%	0	0%	0	100%	8
Gennemskuelighed af modellen	50%	4	38%	3	0%	0	13%	1	0%	0	0%	0	0%	0	0%	0	100%	8
Involvering af interessenter og offentlighed	0%	0	25%	2	38%	3	13%	1	13%	1	0%	0	13%	1	0%	0	100%	8
Total	50%	52	25%	26	13%	13	6%	6	4%	4	1%	1	2%	2	0%	0	100%	104

	Total
Andet - beskriv venligst i tekstfeltet	0

							Total	
Prioritér tre af af nedenstående kvalitetssikringselementer som du finder vigtigst	**1.prioritet**		**2. prioritet**		**3. prioritet**		**Procent**	**Antal**
Guidance med oversigt og definition af de delopgaver en modellering består af	0%	0	67%	2	33%	1	38%	3
Detaljerede skriftlige vejledninger i god modelleringspraksis	67%	2	33%	1	0%	0	38%	3
Kompetence og erfaring hos modelløren	67%	4	17%	1	17%	1	75%	6
Modelleringserfaring hos opdragsgiveren	50%	1	50%	1	0%	0	25%	2
Formaliseret klient-modellør dialog (fx milepælsmøder)	50%	2	25%	1	25%	1	50%	4
Eksternt review flere gange i projektforløbet	100%	3	0%	0	0%	0	38%	3
Modelvalideringer	67%	2	33%	1	0%	0	38%	3
Usikkerhedsvurderinger	0%	0	75%	3	25%	1	50%	4
Opstilling af operationelle nøjagtighedskriterier	100%	2	0%	0	0%	0	25%	2
Dokumentation der gør det muligt at forstå principper og antagelser for modellen	0%	0	75%	3	25%	1	50%	4
Dokumentation der gør det muligt at reproducere modellen	50%	2	25%	1	25%	1	50%	4
Gennemskuelighed af modellen	25%	1	25%	1	50%	2	50%	4
Involvering af interessenter og offentlighed	0%	0	0%	0	100%	2	25%	2
Total	43%	19	34%	15	23%	10	100%	44

	Total
Andet - beskriv venligst i tekstfeltet	**0**

													Total	
Hvad er dine erfaringer vedrørende kvalitetssikring i de modelopgaver du har deltaget aktivt i?	**Altid**		**Ofte**		**En gang imellem**		**Sjældent**		**Aldrig**		**Ved ikke**		**Procent**	**Antal**
Der er en fast plan for hvornår delresultater skal diskuteres (f.eks. Milepælsmøder)	25%	2	50%	4	25%	2	0%	0	0%	0	0%	0	100%	8
Der er løbende kontakt mellem opdragsgiver og rådgiver, så evt. problemer der kan have effekt på det endelige resultat hurtigt kan diskuteres og der kan tages en beslutning	25%	2	38%	3	38%	3	0%	0	0%	0	0%	0	100%	8
Der er en uvildig ekstern reviewer tilknyttet projektet	0%	0	50%	4	50%	4	0%	0	0%	0	0%	0	100%	8
Total	17%	4	46%	11	38%	9	0%	0	0%	0	0%	0	100%	24

	Total
Kommentér gerne din besvarelse af ovenstående	**1**

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn	**Helt enig 1**		**2**		**3**		**4**		**5**		**6**		**Helt uenig 7**		**ved ikke**		**Procent**	**Antal**
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring i udbudsbetingelser og ved udvælgelse af rådgiver	0%	0	25%	2	0%	0	38%	3	13%	1	0%	0	0%	0	25%	2	100%	8
Jeg oplever, at opdragsgiveren er villig til at betale ekstra for kvalitetssikring	0%	0	0%	0	13%	1	38%	3	13%	1	0%	0	0%	0	38%	3	100%	8
Jeg oplever, at opdragsgiveren lægger stor vægt på kvalitetssikring under tilsyn af projektet	0%	0	25%	2	25%	2	25%	2	0%	0	0%	0	0%	0	25%	2	100%	8
Jeg oplever, at modellørerne (rådgiverne) har tilstrækkelig fokus på kvalitetssikring	0%	0	0%	0	38%	3	25%	2	13%	1	13%	1	0%	0	13%	1	100%	8
Jeg oplever, at interessenterne (fx vandselskaber, grønne organisationer, landbruget) lægger stor vægt på kvalitetssikring	0%	0	0%	0	38%	3	0%	0	0%	0	13%	1	0%	0	50%	4	100%	8
Jeg vurderer, at øget fokus på kvalitetssikring har været medvirkende til at forbedre kvaliteten af en modelopgave	25%	2	38%	3	25%	2	0%	0	0%	0	0%	0	0%	0	13%	1	100%	8
Min vurdering er, at den øgede omkostning forbundet ved formaliseret kvalitetssikring er givet godt ud	63%	5	13%	1	0%	0	0%	0	0%	0	0%	0	0%	0	25%	2	100%	8
Total	13%	7	14%	8	20%	11	18%	10	5%	3	4%	2	0%	0	27%	15	100%	56

	Total
Kommentér gerne din besvarelse af ovenstående udsagn	**0**

													Total	
Hvad er dine erfaringer mht. behov og praksis i forbindelse med modellering indenfor den organisation du er ansat i?	**Altid**		**Ofte**		**En gang imellem**		**Sjældent**		**Aldrig**		**Ved ikke**		**Procent**	**Antal**
Vi er ofte flere der arbejder samtidigt på én opgave, og har oplevet behov for klare retningslinier mht. håndtering af data og modelfiler	38%	3	13%	1	25%	2	0%	0	0%	0	25%	2	100%	8
Hvis vi har behov for at arbejde videre med en eksisterende model kan det ikke lade sig gøre pga. manglende dokumentation	0%	0	25%	2	13%	1	38%	3	0%	0	25%	2	100%	8
Total	19%	3	19%	3	19%	3	19%	3	0%	0	25%	4	100%	16

	Total
Kommentér gerne din besvarelse	**0**

																	Total	
I hvilken udstrækning har I indenfor din organisation udviklet procedurer og værktøjer for kvalitetsikring i forbindelse med modellering? Skala fra 1 (Procedurer/værktøjer til alle led i modelleringen) til 7 (Ingen procedure/værktøjer udviklet)	1		2		3		4		5		6		7		ved ikke		Procent	Antal
Vi har rutiner for dokumentation af det tekniske arbejde, der gør det muligt at genoptage modellen eller overdrage denne til en anden modellør	13%	1	0%	0	0%	0	25%	2	0%	0	13%	1	25%	2	25%	2	100%	8
Vi har udviklet rutiner eller programmer for en standardiseret processesering og kvalitetssikring af data, der indgår i modellen så inputfiler altid kan genskabes	13%	1	13%	1	0%	0	13%	1	0%	0	0%	0	38%	3	25%	2	100%	8
Total	13%	2	6%	1	0%	0	19%	3	0%	0	6%	1	31%	5	25%	4	100%	16

	Total
Vi har udviklet andre end ovenstående rutiner til kvalitetssikring - beskriv venligst i kommetarfeltet	0

					Total	
Hvad er dit kendskab til softwareprogrammet MoST, som udviklet i EU-projektet HarmoniQuA?	Ja		Nej		Procent	Antal
Har hørt / læst om det	75%	6	25%	2	100%	8
Har kigget /afprøvet /arbejdet med det	38%	3	63%	5	100%	8
Total	56%	9	44%	7	100%	16

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedestående udsagn om Guidance delen i MoST?	Helt enig 1		2		3		4		5		6		Helt uenig 7		ved ikke		Procent	Antal
Jeg synes godt om de ideer der ligger i MoST mht design af god modelleringspraksis (protokol, principper, mv)	75%	3	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	25%	1	100%	4
Jeg synes, at indholdet af den guidance der er indbygget i MoST er god	0%	0	25%	1	25%	1	25%	1	0%	0	0%	0	0%	0	25%	1	100%	4
Total	38%	3	13%	1	13%	1	13%	1	0%	0	0%	0	0%	0	25%	2	100%	8

	Total
Har du forslag til forbedringer af indholdet og funktionaliteten i forbindelse med guidiance-delen i MoST?	0

																	Total	
På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedenstående udsagn mht. projektrapporteringsfunktionen i MoST?	Helt enig 1		2		3		4		5		6		Helt uenig 7		ved ikke		Procent	Antal
Jeg synes, at projektrapporteringsfunktionen i MoST er nem at forstå	0%	0	0%	0	0%	0	25%	1	0%	0	25%	1	0%	0	50%	2	100%	4
Jeg synes, at MoST er nem at anvende sammen med et projekt	0%	0	0%	0	0%	0	25%	1	0%	0	0%	0	25%	1	50%	2	100%	4
Jeg synes, at MoST rapportering var nytting til at sikre/forbedre kvaliteten af modeleringsarbejdet	0%	0	0%	0	0%	0	0%	0	25%	1	0%	0	25%	1	50%	2	100%	4
Jeg synes, at funktionaliteten i MoST passer godt med arbejdsgangen i et projekt	0%	0	0%	0	0%	0	0%	0	25%	1	25%	1	0%	0	50%	2	100%	4
Total	0%	0	0%	0	0%	0	13%	2	13%	2	13%	2	13%	2	50%	8	100%	16

	Total
Har du forslag til forbedringer af funktionaliteten i forbindelse med projektrapporteringsdelen i MoST?	0

													Total	
Hvordan tror du, at du vil anvende MoST fremover?	Ja		Sandsynligvis		Måske		Næppe		Aldrig		ved ikke		Procent	Antal
Vil du bruge MoST i sin nuværende form i et fremtidigt projekt?	0%	0	0%	0	60%	3	40%	2	0%	0	0%	0	100%	5
Vil du overvje at bruge en forbedret version af MoST i et fremtidigt projekt?	40%	2	20%	1	40%	2	0%	0	0%	0	0%	0	100%	5
Total	20%	2	10%	1	50%	5	20%	2	0%	0	0%	0	100%	10

	Total
Kommentér gerne din besvarelse.	0

Comments by all participants of the questionnaire

Nr.2: Personlige oplysninger: Hvor er din nuværende ansættelse?
(Andet - beskriv venligst i tekstfeltet:)

-

Nr.3: Personlige oplysninger: Hvor har du tidligere været ansat?
(Andet - beskriv venligst)

- Amt
- Amt
- 20 års erfaring fra Danmark og internationalt
- Amt
- Amt
- Amtet
- Amtet, DMU

Nr.4: Hvilke roller har du eller har du haft inden for modelleringsopgaver?
(Andet - beskriv venligst i tekstfeltet)

- generel hydrologisk modellering: konceptuelle, analytiske og overordnede numeriske modeller
- Lidt udvikling

Nr.8: På en skala fra 1 (Meget væsentlig) til 7 (Ubetydelig), hvor væsentligt synes du følgende elementer er for at sikre god kvalitet af en modelleringsopgave?
(Andet - beskriv venligst i tekstfeltet)

- Kunden og interessenter SKAL forstå hvad modellen kan og kan ikke, samt formålet med modellen. Grundlaget for og svaghed i modellen bør være gennemsigtigt til almindeling mennesker.
- Hvis modtageren er bedre klædt på betyder det at behovet for en ekstern review er unødvendigt. Mange er dog reelt ikke klædt på hverken til at udarbejde et udbudsmateriale eller modtage opgaven. Efter min vurdering betyder en modelvalidering på baggrund af de "hårde" reelt at man opnår en dårligere kalibreret model med større modelusikkerheder, hvis kalibreringsdata deles op i kalibrering og validering. Man kan opstille en masse nøjagtighedskriterier, men det fysiske system og kalibreringsdata afgør om det er muligt, derfor ser jeg det som unødvendigt. Efter min opfattelse skal en model altid kalibreres til det bedst mulige ligegyldigt formålet, da fakta er at der i 90 % af tilfældene arbejdes videre med modellen til andet formål.Der bør være meget stor fokus på usikkerheder på både model (stokastiske/Monte Carlo) og på geologi. Sidstnævnte er meget tung økonomisk. Hvis dokumentationen skal kunne reproducere modellen bliver det meget tidskrævende og dermed dyrt, jeg så hellere flere alternative modeller. Det giver ikke så meget mening at involvere interssenter og offentligheden i modelarbejdet andet end overfladisk, da de som oftest ikke er klædt på til det.

Nr.9: Prioritér tre af nedenstående kvalitetssikringselementer som du finder vigtigst
(Andet - beskriv venligst i tekstfeltet)

- Se beskrivelse ved forrige del.

Nr.10: Hvad er dine erfaringer vedrørende kvalitetssikring i de modelopgaver du har deltaget aktivt i?

(Kommentér gerne din besvarelse af ovenstående)

- Det er meget tillidsbaseret og hvor god modelleøren er til at inddrage modtageren i problemstillinger.
- En uvildig ekstern reviewer har sjældent den nødvendige adgang/indsigt i modellen og de anvendte data, dels pga. af for lidt tid, som er afsat til den ekstern reviewer, men også en manglende interesse. / Reviewer ender ofte med kun at se på de overordnet model setup, konklusioner og "model snak" og kan og går ikke i detaljerne. Det er lidt for løst. Intern review samt gennemgang med kunden giver tit et bedre resultat

Nr.11: På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i følgende udsagn

(Kommentér gerne din besvarelse af ovenstående udsagn)

- Jeg oplever at interessenterne er inddraget når det hele er afsluttet
- Jeg mener i høj grad at det handler om tillid og kompetencer for om der opnås et godt produkt. Mine erfaringer er at en stor del vurderer opgaven primært på baggrund af pris og hos nogle også på baggrund af sammensætningen af de folk som skal løse opgaven. Jeg har oplevet, at nogle rådgivere havde tykke ringbind omkring beskrivelser af kvalitetssikring, som man ikke fulgte og mindre rådgivere uden det store forkromede kvalitetssikringsmateriale, som gav mere end de tykke ringbind.
- Der er altid problemer med data for indvindingsmængder på både kildepladsniveau og boringsniveau for både indvinding, afværge og anlægsprojekter. Man skulle tro, det var bedre i 2008 med de gode muligheder, der er for at anvende database og holde disse opdateret.

Nr.12: Hvad er dine erfaringer mht. behov og praksis i forbindelse med modellering indenfor den organisation du er ansat i?

(Kommentér gerne din besvarelse)

- baseret på alle mine erfaringer, også når man overtager andre firma's modeller
- Typisk hvis vi har fået modellen fra anden side. Problemer med dokumentation og især beregningen af netto-nedbøren kan være svært gennemskueligt (befæstelsesgrader, anvendte afgrøder, parametre mv).

Nr.13: I hvilken udstrækning har I indenfor din organisation udviklet procedurer og værktøjer for kvalitetssikring i forbindelse med modellering? Skala fra 1 (Procedurer/værktøjer til alle led i modelleringen) til 7 (Ingen procedure/værktøjer udviklet)

(Vi har udviklet andre end ovenstående rutiner til kvalitetssikring - beskriv venligst i kommentarfeltet)

- Har rutiner(programmer) til at checke geologiske lag, indvindingsdata mv

Nr.16: På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedenstående udsagn om Guidance delen i MoST?

(Har du forslag til forbedringer af indholdet og funktionaliteten i forbindelse med guidiance-delen i MoST?)

- Guiden er det bedste ved MoST. Brugbar og forståelig
- Jeg tror at den er alt for tungt at være generelt operationalt
- En kompetent oversættelse fra engelsk, eller evt. bare en ordliste (oversættelse) af særlige udtryk, ville hjælpe. Selv om jeg grundlæggende er god til engelsk er det svært at forstå en hel del af teksten. Hvis programmet for alvor skal rykke, er det ikke nok at man nogenlunde forstår, hvad det handler om.
- Økonomi til denne del bliver jo hurtigt central for om det kan implementeres!

Nr.17: På en skala fra 1 (Helt enig) til 7 (Helt uenig), hvor enig er du i nedenstående udsagn mht. projektrapporteringsfunktionen i MoST?
(Har du forslag til forbedringer af funktionaliteten i forbindelse med projektrapporteringsdelen i MoST?)

- Brugerfladen i MoST er ikke hensigtsmæssig. Den er tung og medvirker ikke til at forbedre kvalitetssikringen, men skaber mere forvirring og usikkerhed om al data er kommet med og det i sig selv bidrager med usikkerhed. Brugerfladen bør redefineres fra bunden.

Nr.19: Hvordan tror du, at du vil anvende MoST fremover?
(Kommentér gerne din besvarelse)

- Der skal ligges meget mere vægt på generel kommunikation (online peer reviews etc) og meget mindre tid på om man nu har afsluttet et punkt eller hvilket rolle hvem har og hvad man har adgang til. Den meget tunge brugerflade gør at man ikke kan sikre at al data er kommet med.
- Jeg har en KS system
- Økonomi - jeg vil hellere have at vi kan komme længere med usikkerhedskørsler, som giver værdi lige nu og her.