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Estimating the Chance of Success of Information Acquisition for the Norne Benchmark Case

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"While the traditional expected value of information calculation provides only an average value, the chance of success considers the variability in the economic return due to reservoir uncertainties."

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Introduction

This text summarizes the paper of Botechia *et al.* (2018), which aims to assist the decision of whether or not to acquire data, estimating the Chance of Success of a 4D seismic project for the Norne benchmark case.

A key decision in field management is whether or not to acquire information to improve project economics or reduce uncertainties. A widely spread technique to quantify the gain of information acquisition is the Value of Information (VoI). Estimating the possible outcomes of future information without the data is a complex task.

If information provides perfect knowledge of the state of the world, then it is called perfect information and the VoI is referred to as value of perfect information (VoPI). When we have to estimate the value based on expectations we normally prefer to use the terms expected value of information and perfect information (EVoI and EVoPI) to distinguish from a post-mortem study. In practice, information is rarely perfect, presenting some degree of unreliability, which results in the expected value of imperfect information (EVoII). Perfect information works as an upper limit of imperfect information.

The EVoI consists of a single average value and does not give a clear idea of the impact of the information in different scenarios. In light of such limitation, the Chance of Success (CoS) methodology was proposed (Ferreira and Schiozer, 2014) to complement the traditional EVoI approach, estimating a range of possible outcomes for different scenarios. This allows estimating the increase in the expected revenue due to information acquisition.

This approach aims to support the decision to whether or not to acquire information. This information is assumed here to allow identifying the simulation model closest to the real reservoir, and the production strategy optimized for that model should be implemented.

Methodology

The proposed CoS methodology is based on the works of Ferreira and Schiozer (2014) and Ferreira *et al.* (2015), comprising the 6 steps shown in **Figure 1**. In this work, the methodology is applied in the Norne benchmark case (Adlam, 1995). This is a model-based study, where we use representative models (RMs) to represent the uncertain scenarios and we optimize one production strategy for each of them. The information, if acquired, should identify the most-likely RM and, hence, we estimate the increase in the economic return by identifying the most-likely model.

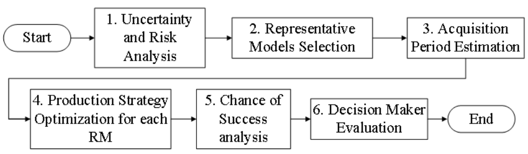

Figure 1: *Methodology to estimate the chance of success of 4D seismic acquisition (adapted from Ferreira and Schiozer, 2014).*

The methodology comprises the following steps:

(1) First, the uncertain parameters of the reservoir model are defined. A production strategy for the base case is set, and this strategy is applied to all other models, in order to calculate the Net Present Value (NPV).

(2) Representative models are selected based on the variability of the input parameters (probability distribution of the uncertain reservoir attributes) and output parameters (NPV, oil recovery factor (RF), cumulative oil (Np), and cumulative water (Wp) production) (Meira *et al.*, 2016). The RMs aim to represent the variability of the uncertainties in a small number of simulation models.

(3) We estimate the best acquisition period by analyzing differences in water saturation maps (Ferreira and Schiozer, 2014).

(4) We optimize one specialized production strategy for each RM at the time of data acquisition and processing. This enables the quantification of the economic impact of the information acquisition assuming that these data has identified the true representative model and the respective strategy should be implemented.

(5) The CoS analysis is performed considering the cumulative probability curve of the ΔNPV for each RM. The ΔNPV is the difference between the NPV with information (NPVwi) and the NPV without information (NPVwoi) (**Eq. 1**) for each RM. NPVwoi refers to the economic return of the production strategy of each RM chosen if information is not acquired, while NPVwi refers to the economic return of the production strategies optimized for each RM, considering the information acquisition.

$$\Delta NPV = NPV_{wi} - NPV_{woi} \qquad \textbf{Eq. 1}$$

(6) Based on the results from previous analyses, the decision maker can end the process (already deciding whether or not the information must be acquired) or re-evaluate by re-starting the process with the following possibilities: (1) improving the accuracy of analyses by choosing more RMs, (2) evaluating a different acquisition period, or (3) improving the production strategy optimization process.

We also compared the EVoI calculation with the CoS analysis. The EVoI gives an average value for the information value and is calculated as the difference between the expected monetary value (EMV) of the project with information and the EMV without information (**Eq. 2**). The EMV is the sum of the NPV of each scenario, weighted by its respective probability of occurrence.

$$EVoI = EMV_{with\ inf.} - EMV_{without\ inf.} \qquad \textbf{Eq. 1}$$

Results

First, we considered perfect information and compared the EVoI with the CoS. Being based on a single value, the EVoI cannot express the variability of the increase in the NPV caused by the reservoir uncertainties that cannot be reduced with that information. When estimating the chance of success of the 4DS project, we considered the cumulative probability curve of ΔNPV for each RM (**Figure 2**). Moreover, the chance of success also depends on the cost of information acquisition, i.e. the increased economic return (ΔNPV) must be higher than the cost to acquire information. In this study, for a chance of success higher than 50%, the seismic data must cost less than USD 32 million.

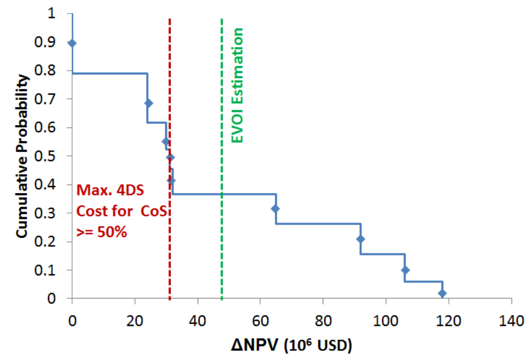

Figure 2: *CoS evaluation for perfect information: cumulative probability curve of the ΔNPV.*

A difference between the EVoI and CoS is noticeable. While the former estimated an average economic gain of USD 47 million, the latter estimated a 45% chance of the 4DS project yielding a higher return than that (**Figure 2**). As these analyses assume perfect information, they provide an upper limit for the value information estimate.

As information is usually imperfect, some unreliability is expected. In this case, there is a probability that incorrect information could be provided, reducing the economic return.

Thus, we performed a sensitivity analysis on the EMV of the 4DS project according to the reliability of the information (**Figure 3**). When information reliability nears 50%, it is better not to acquire the information.

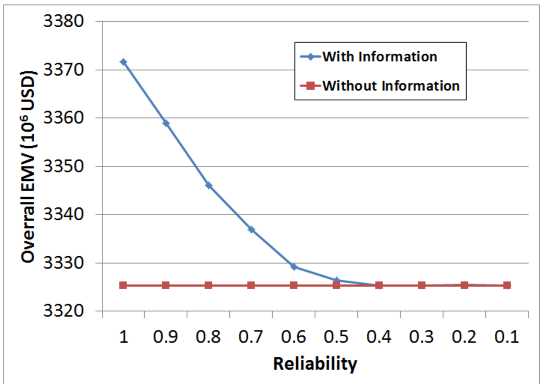

Figure 3: *Variation of the EMV of the 4DS project with information reliability.*

Conclusions

This work presented the practical application of the chance of success (CoS) estimation in the Norne benchmark case, providing decision makers with a tool to decide whether or not to acquire information. In this work, the information would be provided by 4D seismic.

While the traditional expected value of information calculation provides only an average value, the chance of success considers the variability in the economic return due to uncertainty that remains after information acquisition. We assessed perfect information to obtain the upper limit for the VoI.

In this work, when the reliability reaches a level of around 50%, the information no longer has value, because the economic return becomes similar to that of the case without information. Furthermore, highly imperfect information is insufficient to change the perception of the uncertain reservoir and consequently improve decisions.

Acknowledgments

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References

ADLAM, J. 1995. The Norne Field Development Overview. In: Offshore Technology Conference, Houston, 1-4 May. OTC-7925-MS. https://doi.org/10.4043/7925-MS

BOTECHIA, V. E.; SANTOS, D. R.; BARRETO, C. E. A. G.; GASPAR, A. T. F. S.; SANTOS, S. M. G.; SCHIOZER, D. J., 2018. Estimating the Chance of Success of Information Acquisition for the Norne Benchmark Case. *Oil Gas Sci Technol*, 73 (54), pp. 1-14. https://doi.org/10.2516/ogst/2018054

FERREIRA, C. J., SCHIOZER, D. J., 2014. Methodology to Estimate the Chance of Success of a Time-lapse Seismic Project Using Reservoir Simulation. SPE 170674-MS. In: Annual Technical Conference and Exhibition, Amsterdam, The Netherlands. https://doi.org/10.2118/170674-MS

FERREIRA, C. J., DAVOLIO A., SCHIOZER, D. J., 2015. Improving the Estimation of the Chance of Success of a 4D Seismic Project Based on Representative Models. SPE 174386-MS. In: SPE Europec, Madrid, Spain. https://doi.org/10.2118/174386-MS

MEIRA, L. A. A.; COELHO, G. P.; SANTOS, A. A. S.; SCHIOZER, D. J., 2016. Selection of Representative Models for Decision Analysis Under Uncertainty. Comput. Geosci., 88, 67-82. https://doi.org/10.1016/j.cageo.2015.11.012

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"The Chance of Success (CoS) methodology allows the estimation of the probability of increased expected revenue to surpass the costs of information acquisition."

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