

# Uncertainty related to ownership allocation

### By Astrid Marie Skålvik



2014-06-06

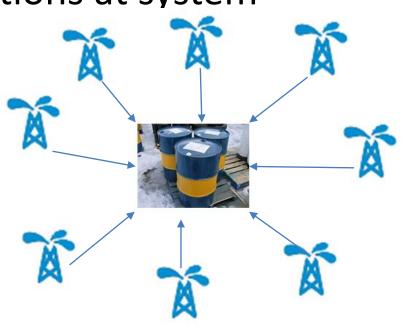


## Content

- Introduction
- Field allocation uncertainty
- Ownership allocation uncertainty
- Risk related to ownership allocation
- Comparison to ownership factor
- Summary

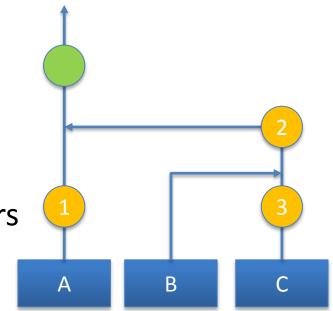
## Introduction

- Increasing attention to uncertainty related to allocation
  - Both field and ownership
- Involve uncertainty calculations at system level
- Straighforward allocation principles, often complex details

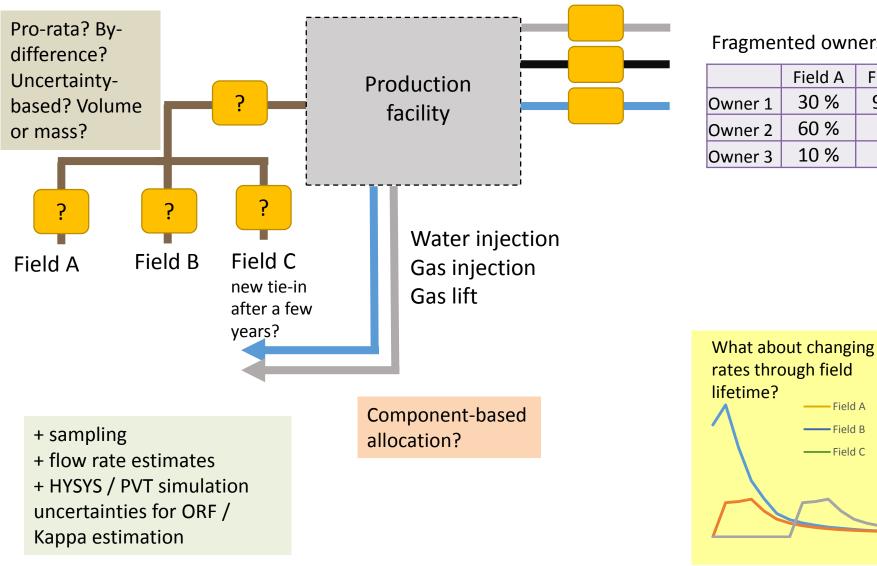


## Field allocation uncertainty

- Affected by
  - Metering station uncertainty
  - Production profile
  - Composition
  - Uncertainty in prosess parameters (P, T, ORF...)
  - System topologi
  - Allocation methodology
  - With ISO Gum, NFOGM tools, Energy Institute guideline - > This is possible to do...



### This is possible to do.....



#### Fragmented ownership

	Field A	Field B
Owner 1	30 %	98 %
Owner 2	60 %	0 %
Owner 3	10 %	2 %

Field A

- Field B

— Field C

### This is possible to do...

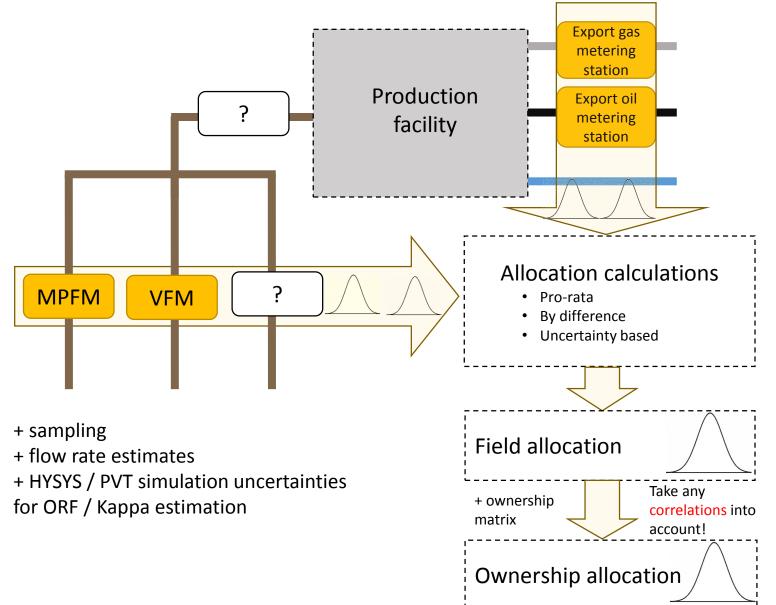
... but it soon gets complicated solving the allocation equations analytically or using an excel model 
$$\begin{split} M^{HC}_{x,i} &= M^{gas}_{x,i} + M^{oil}_{x,i} - M^{gas\,lift}_{x,i} - M^{flare\,gas}_{x,i} \\ M^{gas}_{x,i} &= M^{gas}_{x} \cdot w^{gas}_{x,i} \\ M^{oil}_{x,i} &= M^{oil}_{x} \cdot w^{oil}_{x,i} \\ M^{gas\,lift}_{x,i} &= M^{gas\,lift}_{x} \cdot w^{gas\,lift}_{x,i} \\ M^{gas\,lift}_{x,i} &= M^{HC}_{x} \cdot ORF_{x,i} \end{split}$$

 $M_{x,i}^{oil.calc} = \left( M_x^{gas} w_{x,i}^{gas} + M_x^{oil} w_{x,i}^{oil} - M_x^{gas\,lift} w_{x,i}^{gas\,lift} \right) \cdot ORF_{x,i}$ 

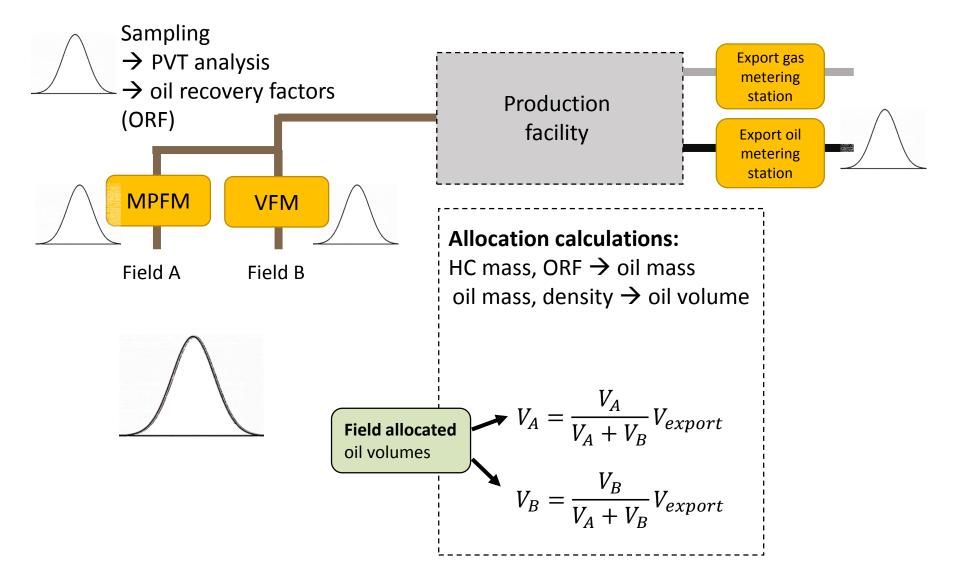
$$\begin{split} U^{*}(M_{x,i}^{oil,calc})^{2} &= \left(\frac{M_{x}^{gas}w_{x,i}^{gas}}{M_{x,i}^{HC}}U^{*}(M_{x}^{gas})\right)^{2} + \left(\frac{M_{x}^{gas}w_{x,i}^{gas}}{M_{x,i}^{HC}}U^{*}(w_{x,i}^{gas})\right)^{2} + \left(\frac{M_{x}^{oil}w_{x,i}^{oil}}{M_{x,i}^{HC}}U^{*}(M_{x}^{oil})\right)^{2} \\ &+ \left(\frac{M_{x}^{oil}w_{x,i}^{oil}}{M_{x,i}^{HC}}U^{*}(w_{x,i}^{oil})\right)^{2} + \left(\frac{M_{x}^{gas\,lift}w_{x,i}^{gas\,lift}}{M_{x,i}^{HC}}U^{*}(M_{x}^{gas\,lift})\right)^{2} \\ &+ \left(\frac{M_{x}^{gas\,lift}w_{x,i}^{gas\,lift}}{M_{x,i}^{HC}}U^{*}(w_{x,i}^{gas\,lift})\right)^{2} + \left(U^{*}(ORF_{x,i})\right)^{2} \end{split}$$

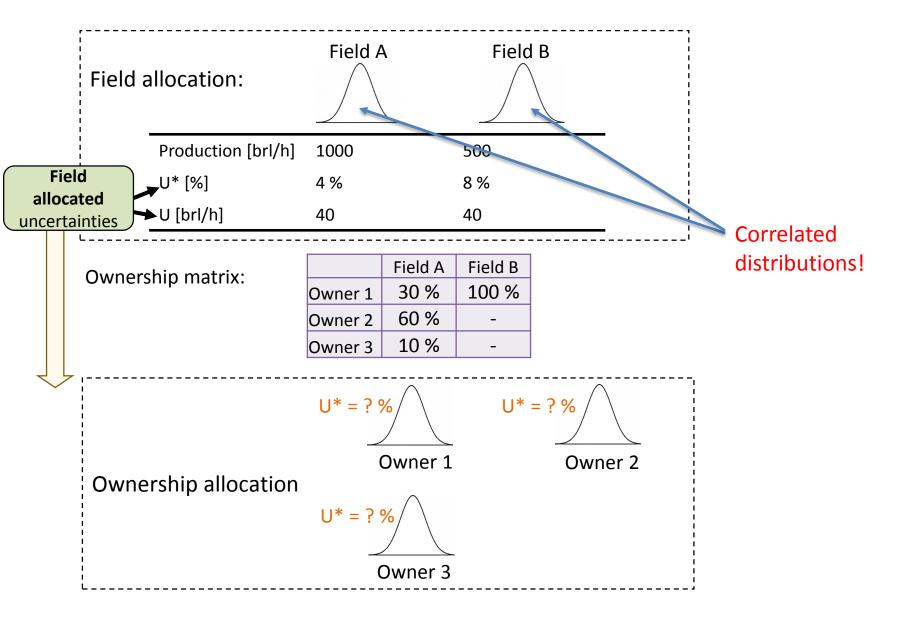
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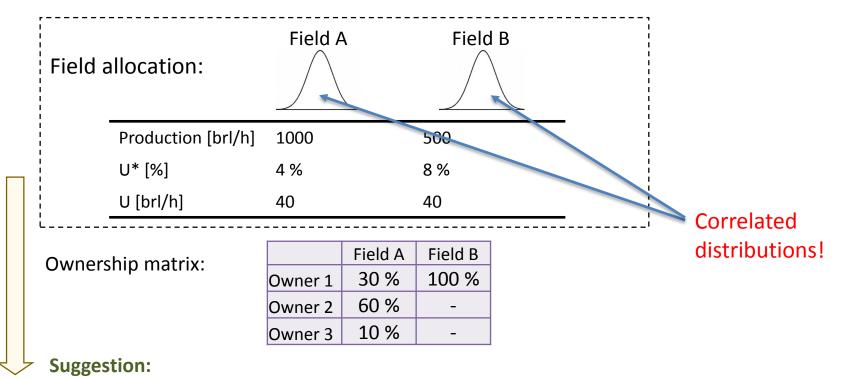
## Modular logic and Monte Carlo simulation



# Example: 2 fields – pro rata allocation of oil volume

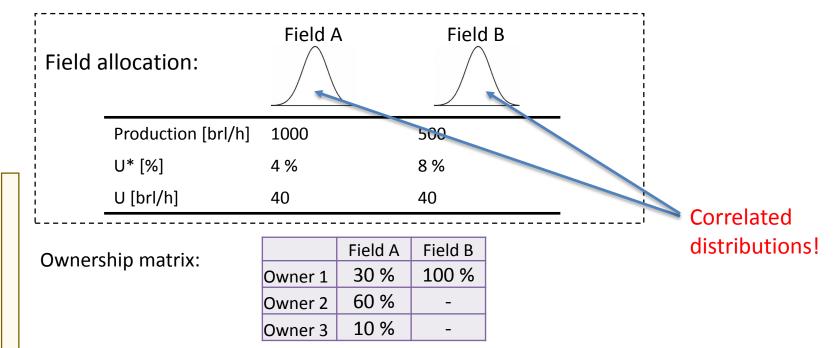






 $U_{owner 1}^* = f(input measurements)$ 

Write down **analytically** the equations relating the allocated quantities to each owner expressed in terms of the input parameters, including any conversions between volume and mass, component calculations etc. Then calculate the **sensitivity coefficients** associated with each input parameter, and perform an uncertainty analysis.



#### Another suggestion:

Multiply *directly* the field allocation uncertainties with the ownership matrix: Rate allocated to owner 1: 0.3\*1000 + 1\*500 = 800 brl/h

#### Assuming correlation = 1:

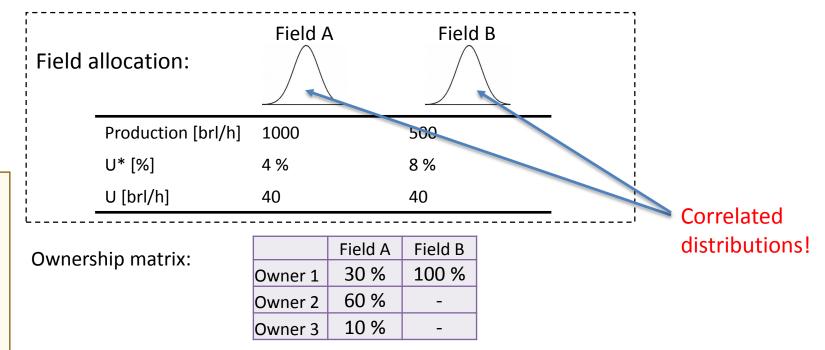
Absolute uncertainty:  $0.3 \cdot 40 + 1 \cdot 40 = 52 \ brl/h$ Relative uncertainty: **6.5 %** 

#### Assuming no correlations:

Absolute uncertainty:  $\sqrt{(0.3 \cdot 40)^2 + (1 \cdot 40)^2} = 42 \ brl/h$ Relative uncertainty: **5.2**%

#### Assuming correlation = -1 :

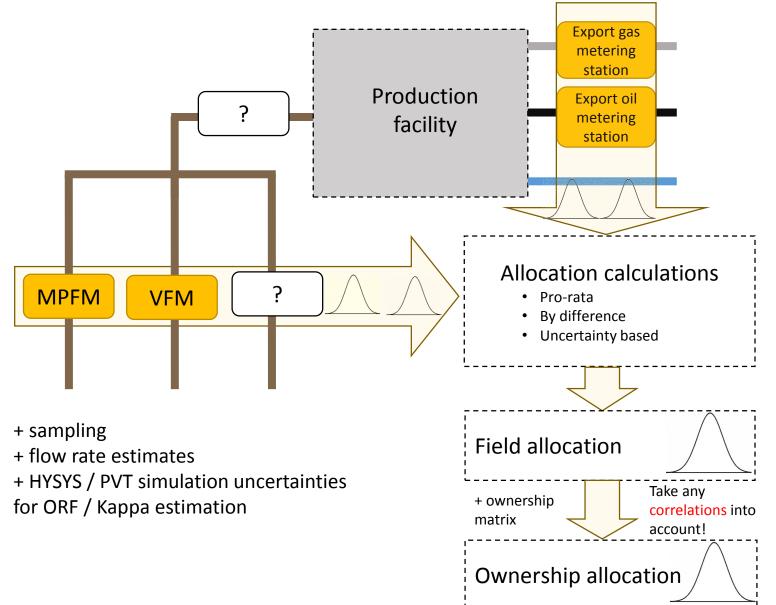
Absolute uncertainty:  $ABS(0.3 \cdot 40 - 1 \cdot 40) = 28 \ brl/h$ Relative uncertainty: **3.5 %** 



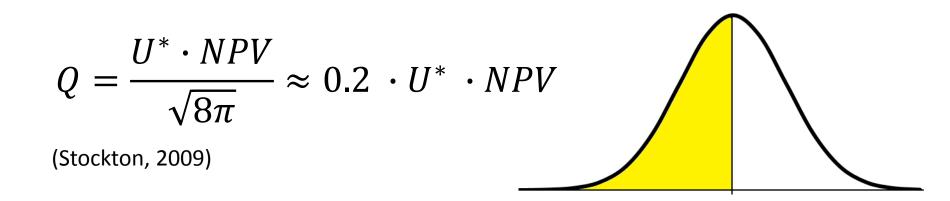
Another suggestion: Multiply the correlated field allocation distributions with the ownership matrix, then calculate the uncertainty from the width of the ownership allocation distribution: Rate allocated to owner 1:

 $0.3 * \underbrace{field A}_{Field B} = \underbrace{field B}_{Owner 1}$ 

## Modular logic and Monte Carlo simulation



# Calculation of risk assocated with allocation uncertainty





#### **Risk exposure for each owner:**

Ignoring correlations or assuming a correlation factor of +1 may result in errenous estimation of the economic risk each owner is exposed to

# Comparison with method based on ownership factor

NORSOK standard I-106

Edition 1, November 2014

ANNEX C System selection criteria (informative)

(...)

In an allocation measurement between 2 production licenses the cost benefit analysis has to take into account that some of the partners may have ownership interests in both production licenses. The reason for this is that a partner with ownership interests in both production licenses will regain some of the loss as he is also owner in the other production license.

To account for this, the average difference in ownership between the production licenses has to be calculated. This can be done by summarizing the absolute value of the differences in ownership for all partners and divide the result by 2. A necessary presumption for performing cost benefit analysis is that all partners behave jointly to the benefit of the license group.

Average difference in ownership = 
$$\frac{1}{2} * \sum_{partner=1}^{n} ABS[(Share in license 1 - share in license 2)]$$

For allocation measurement concept B is acceptable if:

 $(C_A - C_B) > (U_B - U_A) * Risk factor * NPV*Average difference in ownership.$ 

## Comparison with method based on company relative risk

Method taking into account that the risk exposure and income must be calculated for each company separately

 $\frac{Company\ exposure}{Company\ income} = \frac{\sum_{k} E_k \cdot NPV_k \cdot U_k}{\sum_{k} E_k \cdot NPV_k}$ 

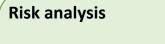
- $E_k$ : Ownership in field k
- $NPV_k$ : Net present value of field k
- $U_k$ : Field allocation uncertainty of field k

From equation proposed in «Konseptvalg fiskale målinger» at NFOGM temadag 2014 (simplified here, no differentiation between the different production years)

This method is comparable with multiplying directly the field allocation uncertainties with the ownership matrix

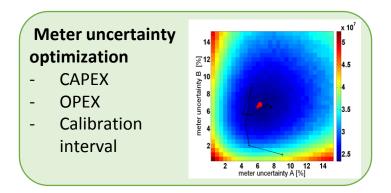
 $\rightarrow$  Method if field-allocated quantities have a correlation factor of +1

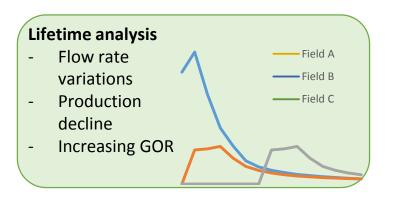
### Other interesting areas

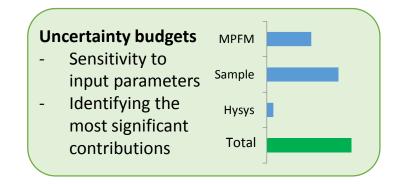


CAPEX + OPEX Allocation uncertainty Flow rates Ownership matrix → Economic risk





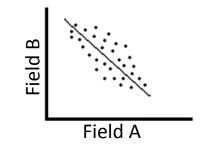


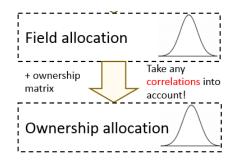


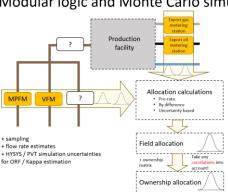
## Summary

- When flows are combined in an allocation system this results in correlation between the field allocated quantities
- This correlation must be taken into account in the ownership uncertainty and risk calculations

These effects are often not intutive → an analysis must be carried out







Modular logic and Monte Carlo simulation