Note on measurement of depletion

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Background

In the absence of market prices, the stock of subsoil resources can be valued using a NPV model in which the value of the asset is calculated as the sum of discounted future earnings. Nobody questions the decomposition used for the monetary asset accounts as this is straightforward mathematics:

$$\mathbf{Vop\text{-}Vcl = RR - rVop - \Delta\_hg - \Delta\_extr}\ ^{2} \qquad \mathbf{[1]}$$

Assuming no holding gains nor changes in the extraction path this expression simplifies to:

$$\mathbf{Vop\text{-}Vcl = RR - rVop} \qquad \mathbf{[2]\ or}$$

$$\mathbf{RR = Vop\text{-}Vcl + rVop} \qquad \mathbf{[3]}$$

The discussion is about the interpretation of the respective terms. Due to the generic similarity of the depletion of a natural resource and consumption of fixed capital (Hill 1998) it seems logical to analyze depletion as a consumption of natural capital. This implies that the interpretation of [3] is that the resource rent (RR) is split into a depletion element (Vop –Vcl) plus a return to natural capital element (rV). Table 1 (with a similar presentation as in Chapter 20 of the 2008 SNA) gives an example in case of an asset e.g. oil that is extracted over a period of 5 years assuming a constant unit RR with constant extraction (100) with a fixed external rate of return of 10%.

Table 1: Derivation of the asset value from a constant extraction path

1.10	expected earnings or RR					
	100					
	90.90909	100				
	82.64463	90.90909	100			
	75.13148	82.64463	90.90909	100		
	68.30135	75.13148	82.64463	90.90909	100	
Value	**416.9865**	348.6852	273.5537	190.9091	100	
Delta Value	68.30135	75.13148	82.64463	90.90909	100	**416.9865**
Income	31.69865	24.86852	17.35537	9.090909	0	83.01346

We clearly see that the RR is split in each period into an income element and a decline in the value of the asset. We also see that income is highest in the first period and eventually becomes 0 in the final period. We also see that the total decline in value 417 is equal to the Vop as expected. While extracting / depleting the resource we have been able to generate income, probably our motivation for doing so.

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[1] The views expressed in this paper reflect the opinion of the author only and do not necessarily reflect those of the United Nations. The argument provided here has been developed as a result of discussions with Ivo Havinga and Herman Smith. Any remaining errors are the sole responsibility of the author.

[2] With Vop the value of the opening stock, Δ_hg changes due to holding gains i.e. unexpected price changes, Δ_extr changes in value due to changed expectations of the future extraction path (e.g. due to discoveries or reclassifications)

The issue that has been at the center of the discussion is what happens in case of an extraction path in which there is a year in which no extraction takes place according to plan.

Table 2: Asset value for an extraction path with one period of 0 extraction.

	1.10	expected earnings or RR					
		100					
		90.90909	100				
		0	0	0			
		75.13148	82.64463	90.90909	100		
		68.30135	75.13148	82.64463	90.90909	100	
Value		334.3419	257.7761	173.5537	190.9091	100	
Delta Value		76.56581	84.22239	-17.3554	90.90909	100	334.3419
Income		23.43419	15.77761	17.35537	9.090909	0	65.65808

As Table 2 shows, the value of the asset clearly increases with an amount equal to rV i.e. 17.4.

How should this increase in value be recorded?
In our opinion this increase does not constitute income: if there is no extraction, there is no capital and labor put to use and therefore no production and also no income to be recorded (this is the point made Ole Gravgard). However, the increase is also not a holding gain as - by assumption - there are no price increases i.e. Δ_hg in [1] is 0 (this is the point made by Peter Comisari).

We believe that *for this specific situation and this year only* the increase should be recorded as other changes in volume of assets (n.e.c) and not within the generation of income account as a return to natural capital. As a result, in this hypothetical situation we would not face negative depletion but 0 depletion.

How to interpret this increase in value of the natural asset that enters through other changes in volume of assets account?
Although leading to the same conclusion, 2 dissenting interpretations have been suggested that we present both in order to stimulate discussion:

Interpretation 1: Volume increases can be the result of quantity and / or quality i.e. V = f(quantity, quality). Obviously, it cannot be due to an increase in the quantity of oil as we assume there are no discoveries or reappraisals i.e. Δ_extr in [1] is 0. Therefore the increase in value is due to an increase in quality. It is evidently not a quality increase as in the case of the ageing of wine – this would imply that additional output is produced while the goods are held 'in store': the oil remains physically the same.
The increase in quality is due to the fact that the stock in the ground becomes more accessible (see also Hill 1998) as a result of the activity of extraction (or the lack of it) given relative prices, extraction profiles, discount rates, etc. (i.e. everything remaining the same). With the passage of time it becomes a different asset which is reflected in the fact that it would also obtain a different (higher) value when brought to the market.

Interpretation 2: In this specific situation, the analogy between depletion and consumption of fixed capital fails. Fixed assets depreciate even when not used due to the mere fact of aging. By contrast, subsoil assets do not deplete when they are not extracted. In other words, in this situation we have an ill-specified model. The error is inherent in using an NPV model and is due

to imposing an exogenous rate of return rather than an endogenous rate of return which would not have lead to a positive return value.
According to this interpretation there is no reason to refrain from using NPV as this is a hypothetical situation. Even when it were to occur for a specific oil field, we should realize that what is recorded in the monetary asset accounts covers all oil fields in a country and it is extremely unlikely that no extraction would happen at all oil producing fields at the same time. The depletion that will be recorded refers always to a basket of assets and – this is a result by Hulten (2007) – the average experience of a group of assets is better approximated by geometric depreciation that by other forms even if each of the component assets in the group follows a different pattern. In short such an outlier would be smoothed out.

References:

Accounting for depletion in the SNA, Peter Hill 1998, Presented at the One Day Meeting on Accounting for Environmental Depletion, Paris, 28 September 1998.

Accounting for the value of time passing and the depletion of natural resources -reconsideration and some suggestions, Ole Gravgård, paper presented at the 13th Meeting of the London Group, Brussels 2008

'Time passing' and the measurement of depletion, Peter Comisari, paper presented at the 13th Meeting of the London Group, Brussels 2008

Simplified depreciation guidelines for estimating capital incomes and stocks, Charles R. Hulten, University of Maryland 2007