



Why We (Really) May Have Entered an Oil Production Plateau

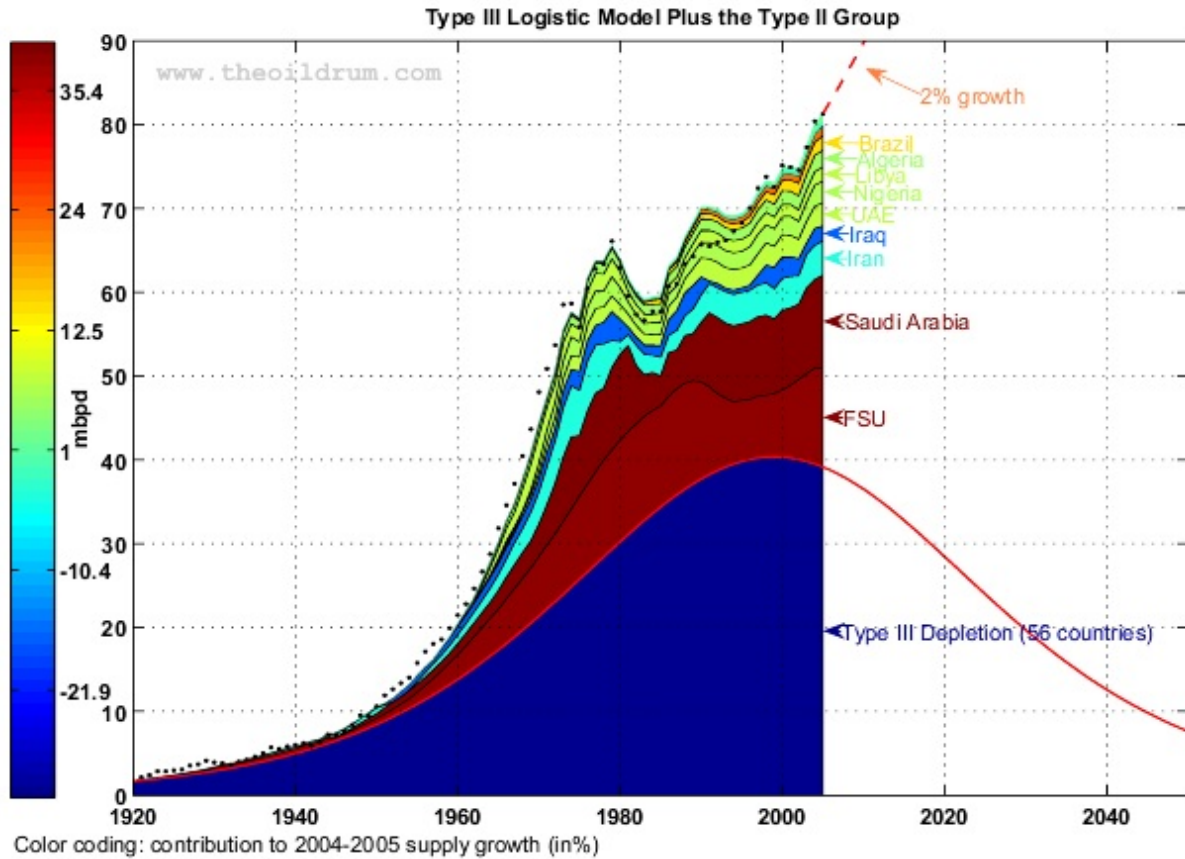
Posted by [Sam Foucher](#) on November 13, 2006 - 11:45am

Topic: [Supply/Production](#)

Tags: [depletion](#), [m. king hubbert](#), [russia](#), [saudi arabia](#), [type ii](#), [type iii](#), [world production](#) [[list all tags](#)]

We know that some countries (around 56) have seen their production peaked (also called type III depletion). The remaining group consists of 17 countries that have the potential to grow or maintain their current production (the type II group). I propose to apply the HL technique only on the total production from the the type III group and try to assess the future production decline coming from that group. My observations are the following:

- The type III group (~56 countries) seems to have peaked around 1999 at 40 mbpd with an URR around 1.0Tb and a cumulative production of 600 Gb in 2005.
- The decline rate in the group III is currently around 1% per year but will accelerate with time and possibility reach 2% after 2010
- When a high case scenario for the production derived from the Canadian Tar Sands is included, the decline rate will be reduced around 0.5% per year until 2010.
- In order to satisfy a relatively moderate demand growth at 1.5%/year, the supply coming from the type II group should be around 3.5-4.0%/year and reach a production level of 56-59 mbpd in 2010 (from 40 mbpd in 2005).
- The total production from Russia and Saudi Arabia that are leading the type II group, is almost flat since mid-2004 despite record oil prices.



Production from the type II group added to the logistic curve modeling the production coming from the type III group. The dots represents the actual values for the world production of crude oil + NGL.

Cautionary note: In this story, I'm talking strictly about production of Crude Oil plus Condensate and NGPL (CO+NGL in short).

Notations:

- mbpd= Millions of barrels per day
- Gb= Billions of barrels (10^9)
- Tb= Trillions of barrels (10^{12})
- NGPL= Natural Gas Plant Liquids
- NGL= Natural Gas Liquids (lease condensate + NGPL)
- URR= Ultimate Recoverable Resource

Production per Countries

The production data for 73 countries are composed of the following datasets (Contribution of Jean Lahèrre, Stuart Staniford and put together by Roberto Canogar):

- 1857-1958: from "API Facts and Figures Centennial edition 1959" (thanks to Jean Lahèrre and Stuart Staniford)
- 1959-1964: from "Twentieth Century Petroleum Statistics2004" of DeGolyer & MacNaughton.
- 1965-2005: [BP Statistical Review of World Energy](http://www.bp.com/energyreview).

The two figures below are giving different views on how each country is contributing to the world production of crude oil + NGL.

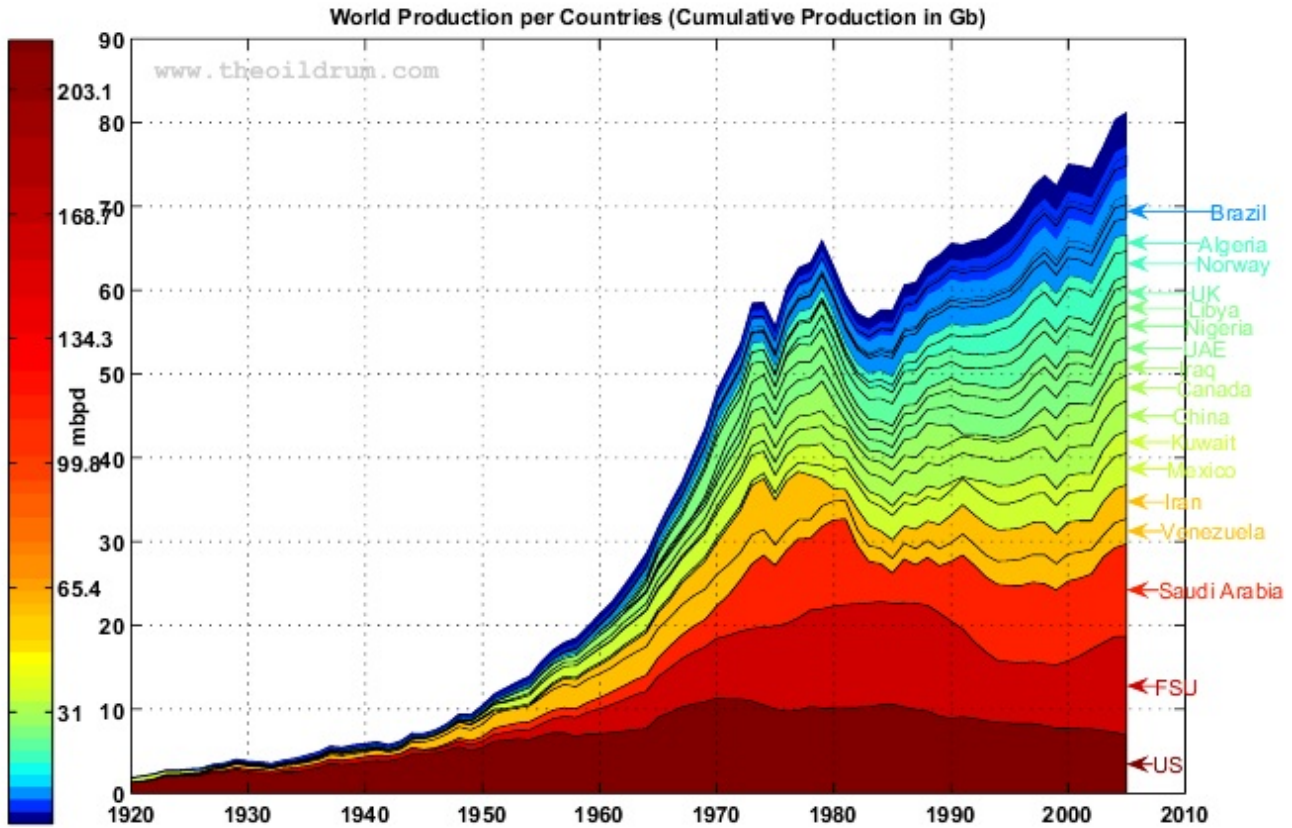


Fig. 1- World production of Crude oil plus NGL (CO+NGL). Color function of the cumulative production in Gb.

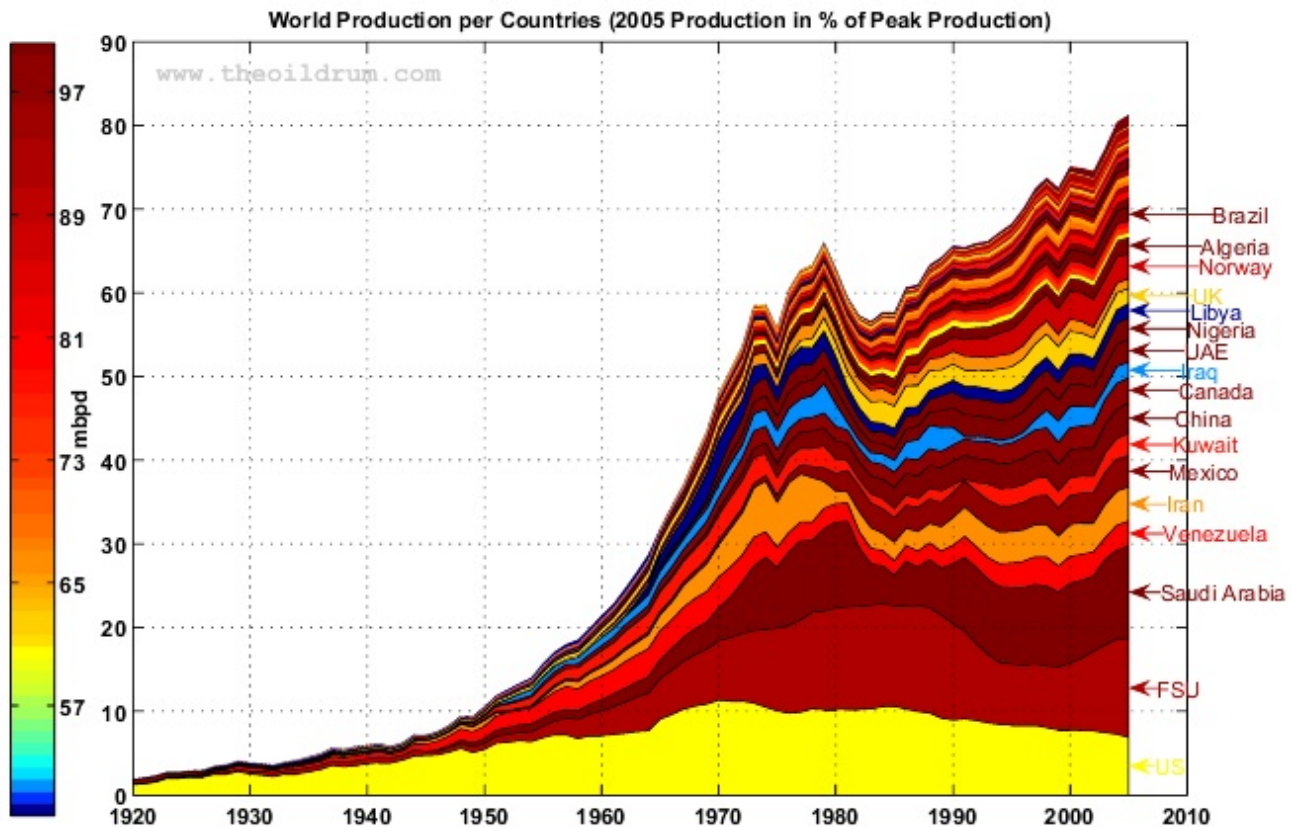


Fig. 2- World production of Crude oil plus NGL (CO+NGL). Color function of the 2005 production in % of the maximum production.

The Type III Group

The Type III depletion is when a country or region can no longer maintain or increase its total production, I quote [Chris Skrebowski](#):

Type III depletion is when a country produces less oil in a year than it did in the previous year. This can be identified quite readily from public production databases (see Petroleum Review, August 2004 and August 2005). Type III depletion will increase as additional countries move into decline, but will reduce as the volumes produced by the countries in decline decreases. In 2003, Type III depletion was running at around 1.1mn b/d, but in 2004 it fell back to around 900,000 b/d (significant revisions to production data tend to confuse the picture). Over the next few years a number of countries are likely to move into decline - Denmark, China, Malaysia, Mexico, Brunei and India are the obvious candidates and account for over 12% of global production - so a reasonable working assumption is that Type III depletion will increase, although with something of a saw-tooth profile. Recent statements by oil companies (Petroleum Review, August 2005) have tended to indicate that overall depletion (Types I, II and III) is running at between 4% and 6%. Analysis of recent company production (see p24) tends to confirm that using a 5% figure is a reasonable approximation. Demand growth is subject to quite rapid swings, but appears to average around 2%/y.

I chose to include 56 countries (see Table I) that have peaked or that are believed to peak within the next two years (the [ASPO Newsletter #59](#) contains also a table with the average decline per countries for regular oil).

Country	2005 Prod. (mbpd)	Peak Prod.	Cumulative Prod. (Gb)	P/Q (%)
US	6.83 (60.46%)	11.30 (1970)	216.90	1.15
Venezuela	3.01 (80.10%)	3.75 (1970)	59.70	1.84
Mexico	3.76 (98.30%)	3.82 (2004)	37.51	3.66
Kuwait	2.64 (79.16%)	3.34 (1972)	37.23	2.59
China	3.63 (100.00%)	3.63 (2005)	33.06	4.00
Canada	3.05 (98.77%)	3.09 (2004)	32.22	3.45
UK	1.81 (62.15%)	2.91 (1999)	23.75	2.78
Indonesia	1.14 (67.42%)	1.69 (1977)	22.49	1.84
Norway	2.97 (86.86%)	3.42 (2001)	20.56	5.27
other Europe	0.46 (60.76%)	0.76 (1986)	10.10	1.67
Egypt	0.70 (74.00%)	0.94 (1993)	9.58	2.65
Argentina	0.72 (81.46%)	0.89 (1998)	9.51	2.78
Qatar	1.10 (100.00%)	1.10 (2005)	8.38	4.78
Oman	0.78 (81.17%)	0.96 (2001)	8.00	3.56

India	0.78 (96.07%)	0.82 (2004)	7.58	3.77
Australia	0.55 (68.48%)	0.81 (2000)	7.22	2.80
Colombia	0.55 (65.51%)	0.84 (1999)	6.47	3.10
Malaysia	0.83 (96.50%)	0.86 (2004)	6.41	4.71
Rumania	0.11 (36.31%)	0.31 (1976)	5.59	0.74
Syria	0.47 (78.63%)	0.60 (1995)	4.46	3.84
Ecuador	0.54 (100.00%)	0.54 (2005)	3.85	5.13
Trinidad	0.17 (74.35%)	0.23 (1978)	3.35	1.86
Brunei	0.21 (78.93%)	0.26 (1979)	3.35	2.24
Gabon	0.23 (64.29%)	0.36 (1996)	3.20	2.67
Peru	0.11 (56.63%)	0.20 (1980)	2.43	1.67
Yemen	0.43 (93.30%)	0.46 (2002)	2.20	7.07
other Asia	0.20 (71.97%)	0.28 (1993)	2.19	3.32
Rep. of Congo	0.25 (86.42%)	0.29 (1999)	1.83	5.06
Denmark	0.38 (96.67%)	0.39 (2004)	1.74	7.90
Other S. & Cent. America	0.14 (92.98%)	0.15 (2003)	1.52	3.41
Tunisia	0.07 (62.63%)	0.12 (1980)	1.32	2.05
Italy	0.12 (100.00%)	0.12 (2005)	1.04	4.12
Sudan	0.38 (100.00%)	0.38 (2005)	0.61	22.67
Germany	0.00 (0.00%)	0.15 (1964)	0.56	0.00
Austria	0.00 (0.00%)	0.07 (1955)	0.34	0.00
Bahrain	0.00 (0.00%)	0.05 (1964)	0.31	0.00
Poland	0.00 (0.00%)	0.04 (1909)	0.30	0.00
Hungary	0.00 (0.00%)	0.04 (1964)	0.16	0.00
Netherlands	0.00 (0.00%)	0.04 (1964)	0.16	0.00
France	0.00 (0.00%)	0.06 (1964)	0.16	0.00
Japan	0.00 (0.00%)	0.02 (1963)	0.14	0.00
Burma	0.00 (0.00%)	0.02 (1939)	0.11	0.00
Chile	0.00 (0.00%)	0.04 (1964)	0.08	0.00
Neutral Zone	0.00 (0.00%)	0.08 (1958)	0.08	0.00
Yugoslavia	0.00 (0.00%)	0.04 (1964)	0.07	0.00
Albania	0.00 (0.00%)	0.01 (1962)	0.06	0.00
Bolivia	0.00 (0.00%)	0.01 (1957)	0.04	0.00
Pakistan	0.00 (0.00%)	0.01 (1964)	0.04	0.00
Turkey	0.00 (0.00%)	0.02 (1964)	0.03	0.00
New Guinea	0.00 (0.00%)	0.01 (1954)	0.02	0.00
Czechoslovakia	0.00 (0.00%)	0.00 (1953)	0.02	0.00
Bulgeria	0.00 (0.00%)	0.01 (1958)	0.02	0.00

Morocco	0.00 (0.00%)	0.00 (1963)	0.01	0.00
Israel	0.00 (0.00%)	0.00 (1964)	0.01	0.00
Cuba	0.00 (0.00%)	0.00 (1956)	0.00	0.00
Formosa	0.00 (0.00%)	0.00 (1941)	0.00	0.00

Table I. Countries in the Type III group (the percentage number between parenthesis in the second column is the 2005 production in % of the maximum production).

The inclusion of some countries in this group can be questioned:

1. Venezuela: regular oil production has peaked but an increase in the Orinoco oil sands production is not impossible.
2. Canada: conventional production has peaked but syncrude production derived from tar sands is planned to reach almost 3.5+ mbpd in 2020. This point is further discussed in the section below.
3. Kuwait has not peaked yet but his largest field (Burgan) is in decline and Kuwait has [admitted to have inflated its reserves](#).
4. China: the ASPO is saying that this country is about to peak but it is not showing in the data yet.

I then perform a [Hubbert Linearization](#) on the total production from these 56 countries. We can see that the fit is quite good and gives an URR around 1.0 Tb with a logistic growth rate at 5.8%. The peak date is obtain by matching cumulative production values and gives 1999 as the peak year. Cumulative production for this group is about 600 Gb (60% of the URR).

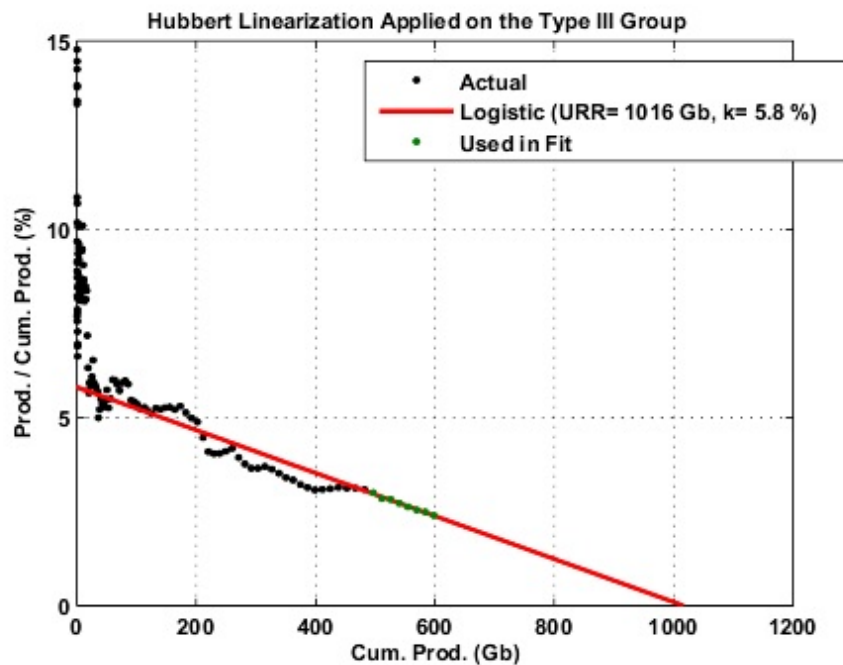


Fig. 3- Hubbert linearization for the total production from the type III group.

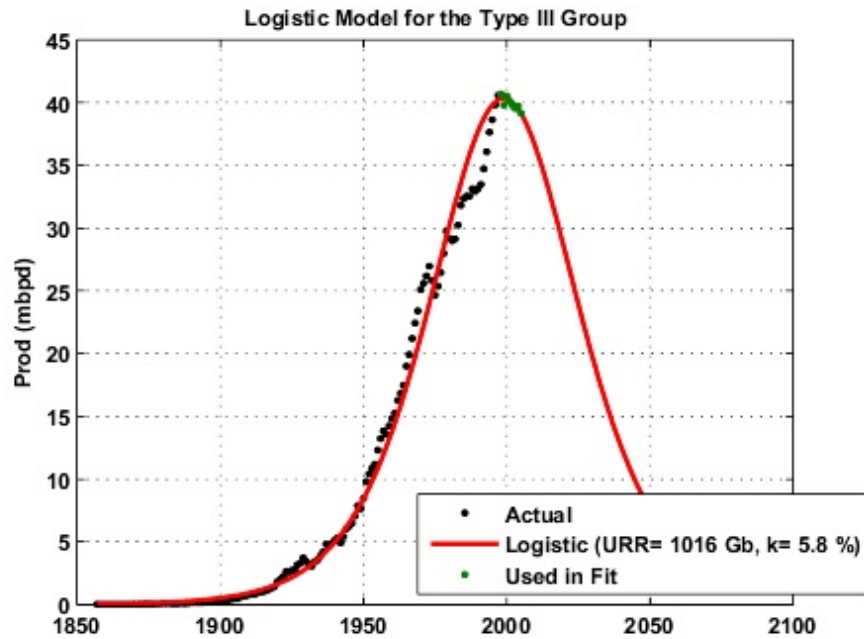


Fig. 4- Corresponding logistic curve (or Hubbert curve) with a peak production in 1999.

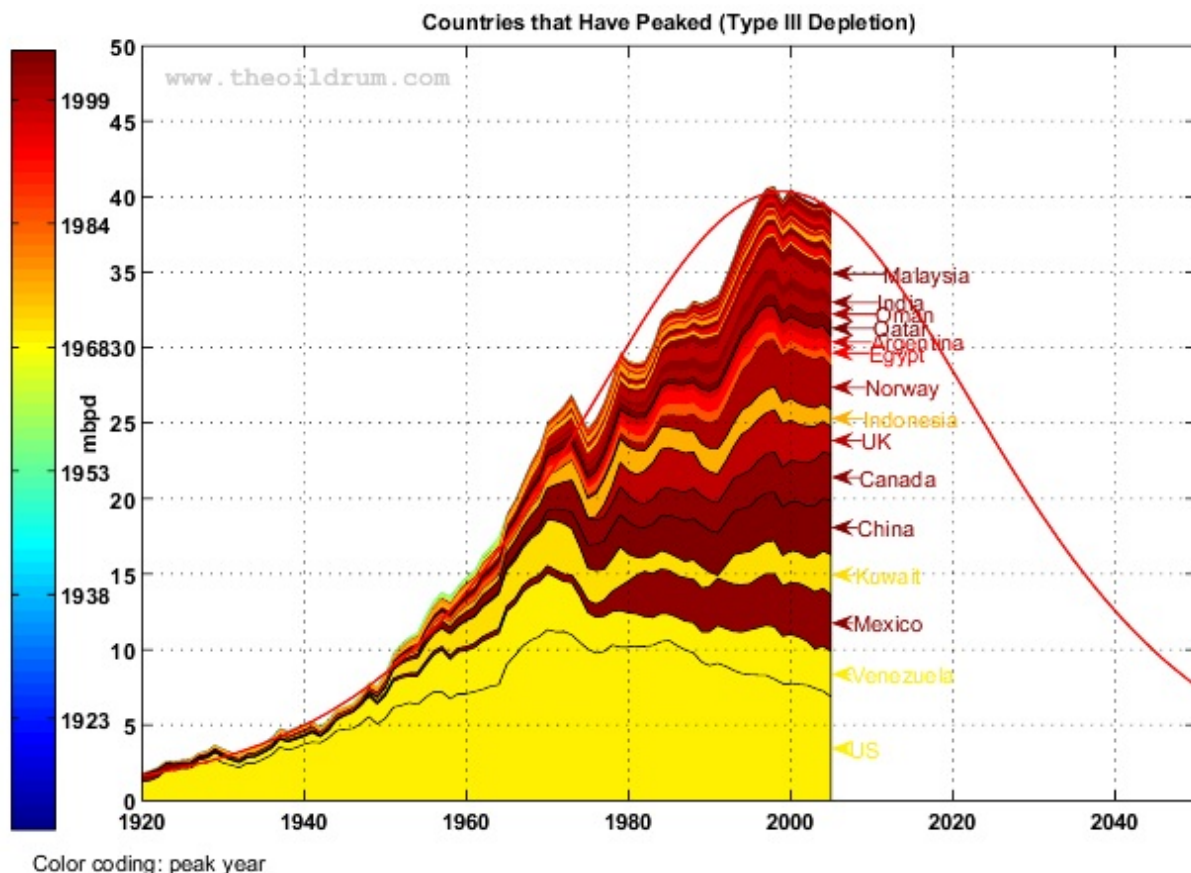


Fig. 5- Logistic curve with production profiles from the countries in the type III group.

What About the Canadian Tar Sands?

Synthetic Crude Oil (SCO) production derived from the Canadian Tar Sands is projected to grow by 2.5+ mbpd in 2020 (see the [Canadian Oil Sands Production Update](#) for details). I added one the most optimistic forecast (from CERI) to the group III logistic model as shown on Figure 6

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 below. I assumed that the level of production post-2020 will stay constant. The strong increase in syncrude production could slow down the group III decline until 2012-2015.

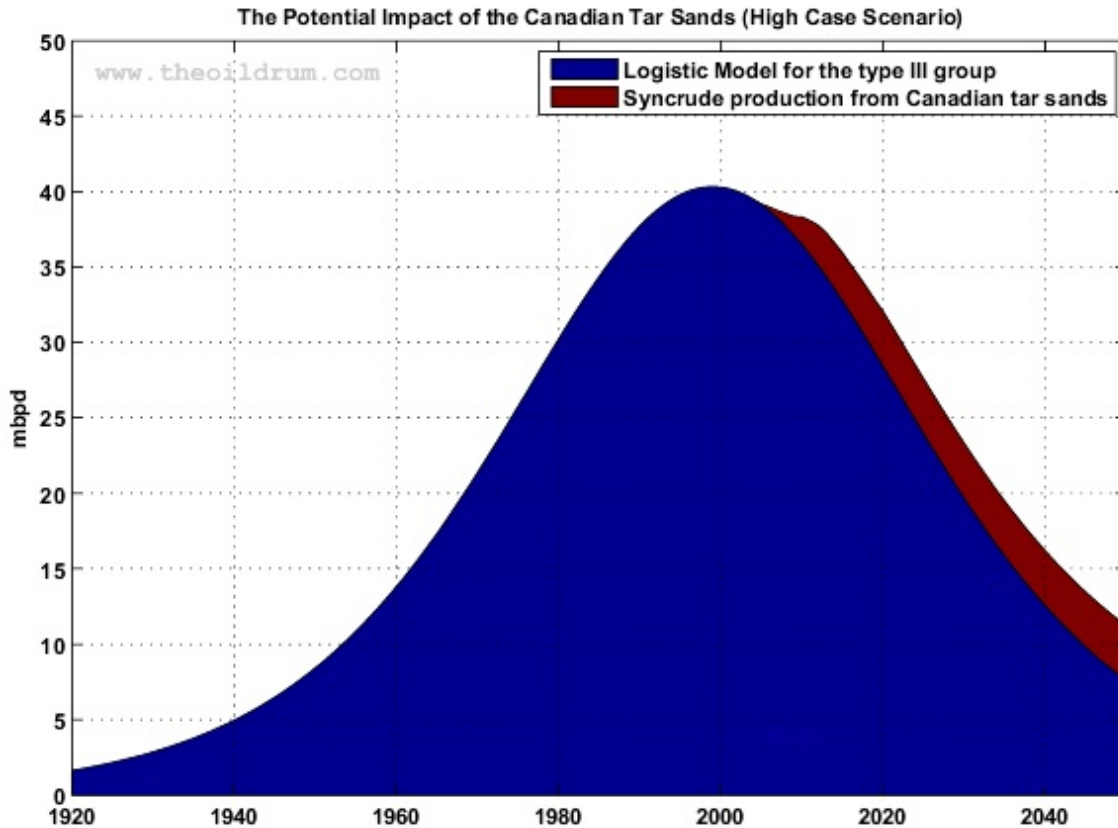


Fig. 6- Logistic model for the group III on which a syncrude from the Canadian tar sands forecast has been added.

What's Left?

The remaining group of countries is what I call the type II group which are believed to be capable of increasing or at least maintaining production levels for the coming years (see table II). As we can see on Figure 7, this group is dominated by the FSU (Former Soviet Union which includes Russia, Azerbaijan, Turkmenistan, Kazakhstan and Uzbekistan) and Saudi Arabia. In particular, the FSU was the main source for the strong supply increase that has been observed since 2000.

Country	2005 Prod. (mbpd)	Peak Prod.	Cumulative Prod. (Gb)	P/Q (%)
FSU	11.84 (93.59%)	12.66 (1987)	161.26	2.68
Saudi Arabia	11.04 (100.00%)	11.04 (2005)	116.17	3.47
Iran	4.05 (66.82%)	6.06 (1974)	59.14	2.50
Iraq	1.82 (52.18%)	3.49 (1979)	29.89	2.22
UAE	2.75 (100.00%)	2.75 (2005)	26.88	3.74
Nigeria	2.58 (100.00%)	2.58 (2005)	25.69	3.67
Libya	1.70 (50.70%)	3.36 (1970)	25.07	2.48
Algeria	2.02 (100.00%)	2.02 (2005)	19.36	3.80
Brazil	1.72 (100.00%)	1.72 (2005)	8.84	7.09
Angola	1.24 (100.00%)	1.24 (2005)	5.78	7.85

Vietnam	0.39 (91.83%)	0.43 (2004)	1.41	10.16
Other ME	0.05 (61.18%)	0.08 (1970)	1.20	1.46
Cameroon	0.06 (32.17%)	0.18 (1985)	1.11	1.91
Tailand	0.28 (100.00%)	0.28 (2005)	0.91	11.06
Equatorial Guinea	0.35 (100.00%)	0.35 (2005)	0.62	20.92
other Africa	0.07 (96.87%)	0.07 (2004)	0.53	4.95
Chad	0.17 (100.00%)	0.17 (2005)	0.13	47.40

Table II. Countries in the Type II group.

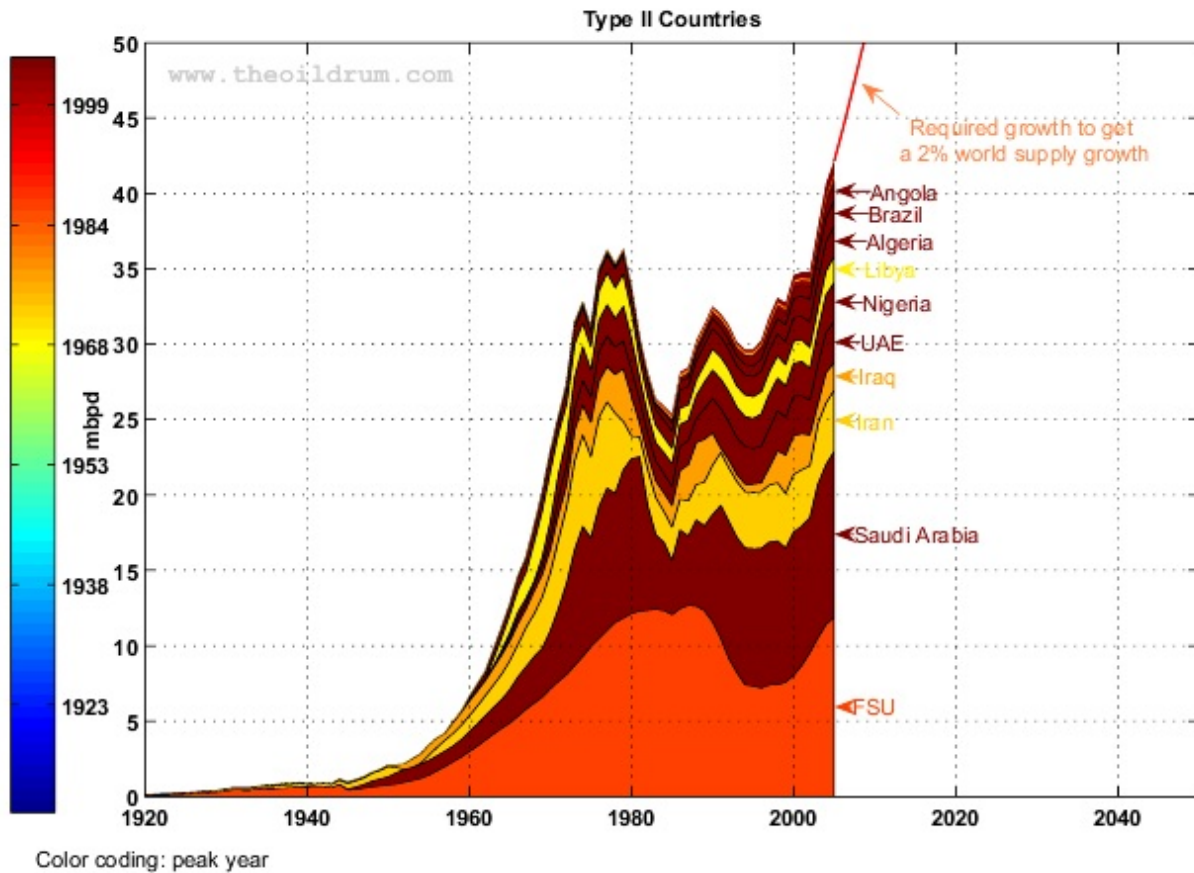


Fig. 7- Production from the type II group. The red line is the projected production required to satisfy a world supply growth at 2%/year and a logistic decline for the type III group.

When the Hubbert Linearization is applied on the group II (Figure 8), we can see that the Logistic curve fit is not very good compared to the group II and cannot follow the recent production increase. One explanation is that the oil production from this group has been altered by many oil shocks and production quotas. In addition, the production is relatively immature with a cumulative production (484 Gb) only at 34.7% of the URR. For now, I choose not to retain this model.

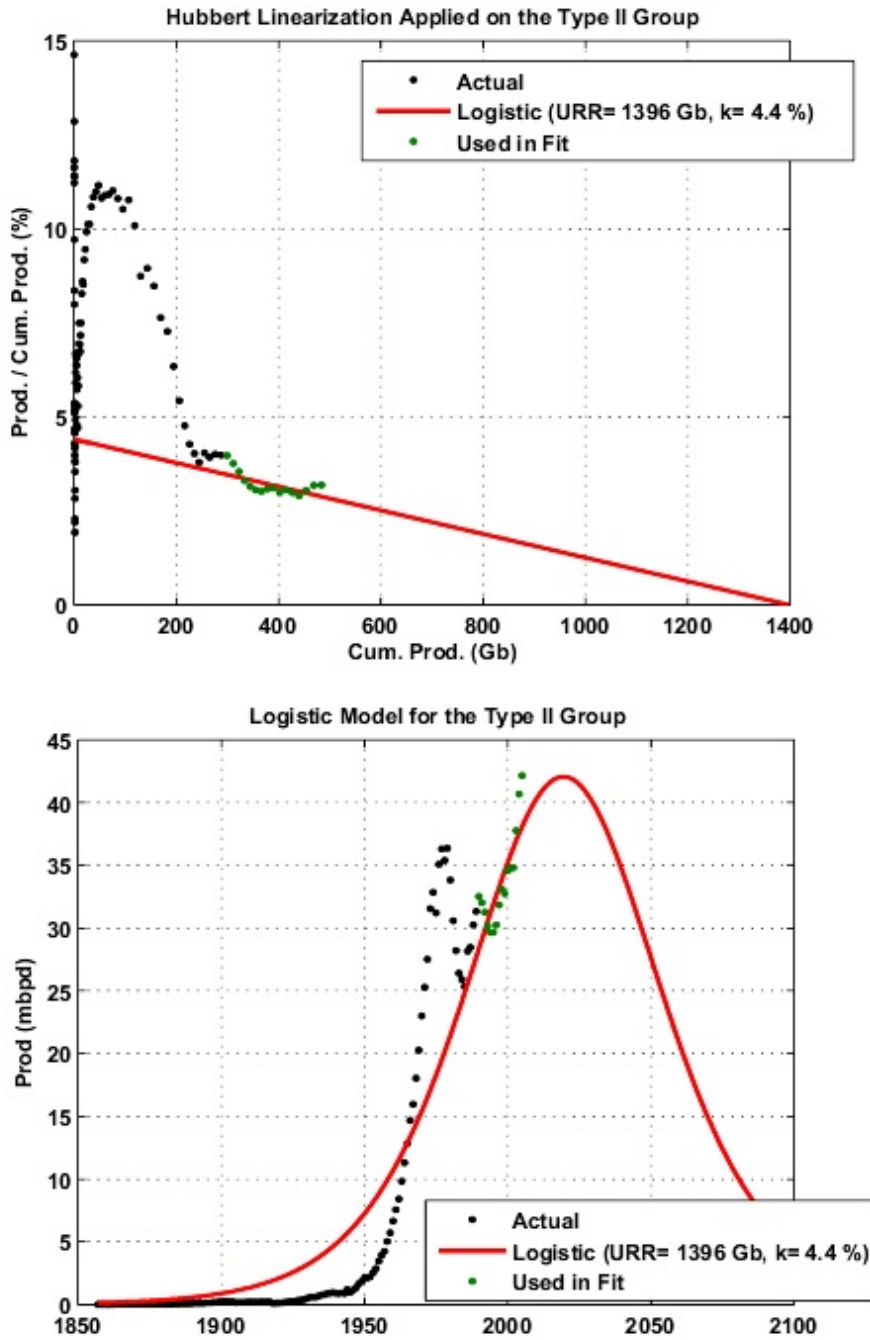


Fig. 8- Hubbert linearization for the total production from the type II group and corresponding logistic curve (or Hubbert curve) with a peak production in 2019.

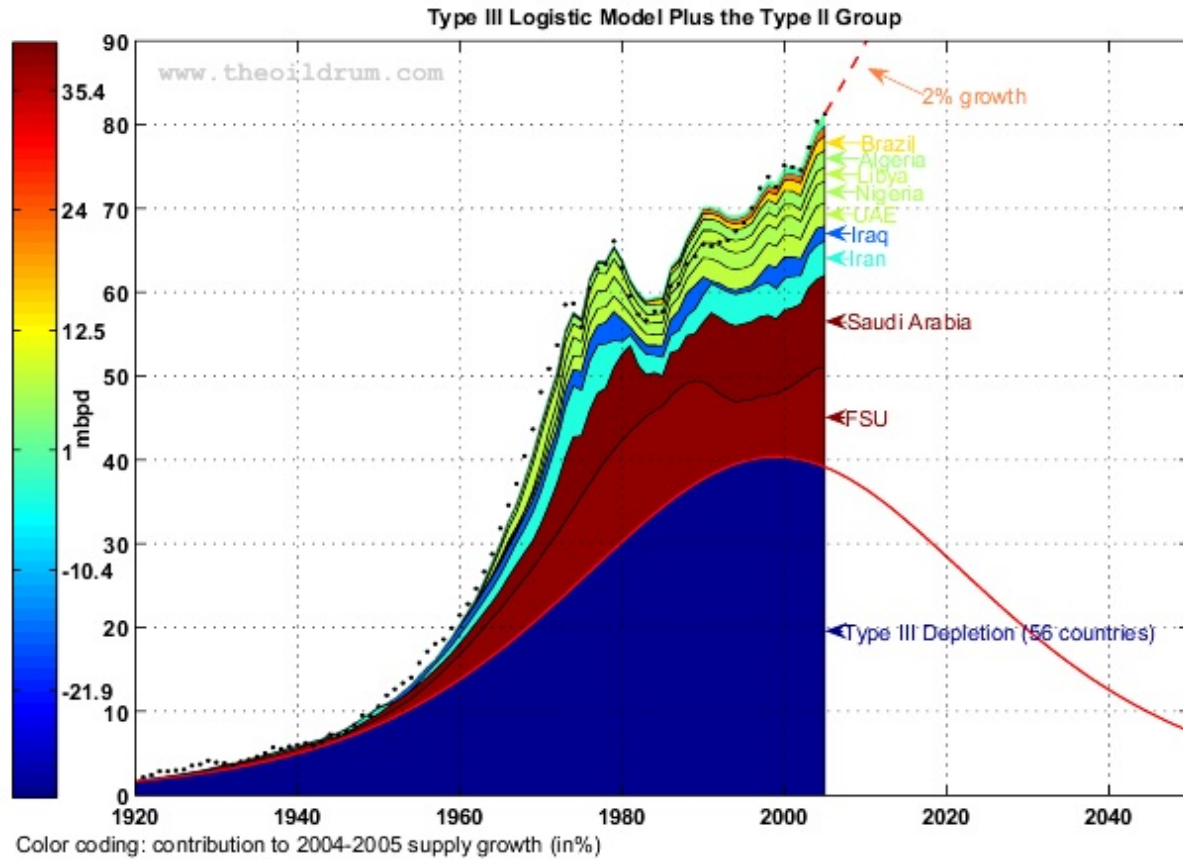


Fig. 9- Production from the type II group added to the logistic curve modeling the production coming from the type III group. The dots represents the actual values for the world production of crude oil + NGL.

How Challenging Will be Future Production Growth?

Figures 10 and 11 below are summarizing the challenges we are facing in the coming years:

- The Type III group is pulling down world production by 0.4 mbpd/year but the production loss may reach 0.7 mbpd/year in 2012.
- In order to maintain a world supply growth around 1.5%/year and compensate for the group III decline, production by the type II group has to grow by more than 2.0 mbpd per year (or 4%/year, i.e. doubling of the production every 17 years!).
- In 2005, we lost nearly 0.6 mbpd from the group III and got only 1.5 mbpd of new supply from the type II group (see Figure 11 below).
- In 2006, preliminary estimates are showing a weak growth for Russia (+0.94%) and a decline for Saudi Arabia (-2.0%). Most forecasts are predicting a flat production for Saudi Arabia around 10 mbpd. Russia will probably have a weak growth for the next few years (see [Dave's excellent post](#) and Ray Leonard's [presentation](#)).
- A strong growth in the production of synthetic crude oil from the Canadian Tar sands may slow down the decline in the group III and create a kind of plateau until 2012-2015.
- Future production from Iraq could be a key element but unfortunately this country will probably remains in turmoil for years.

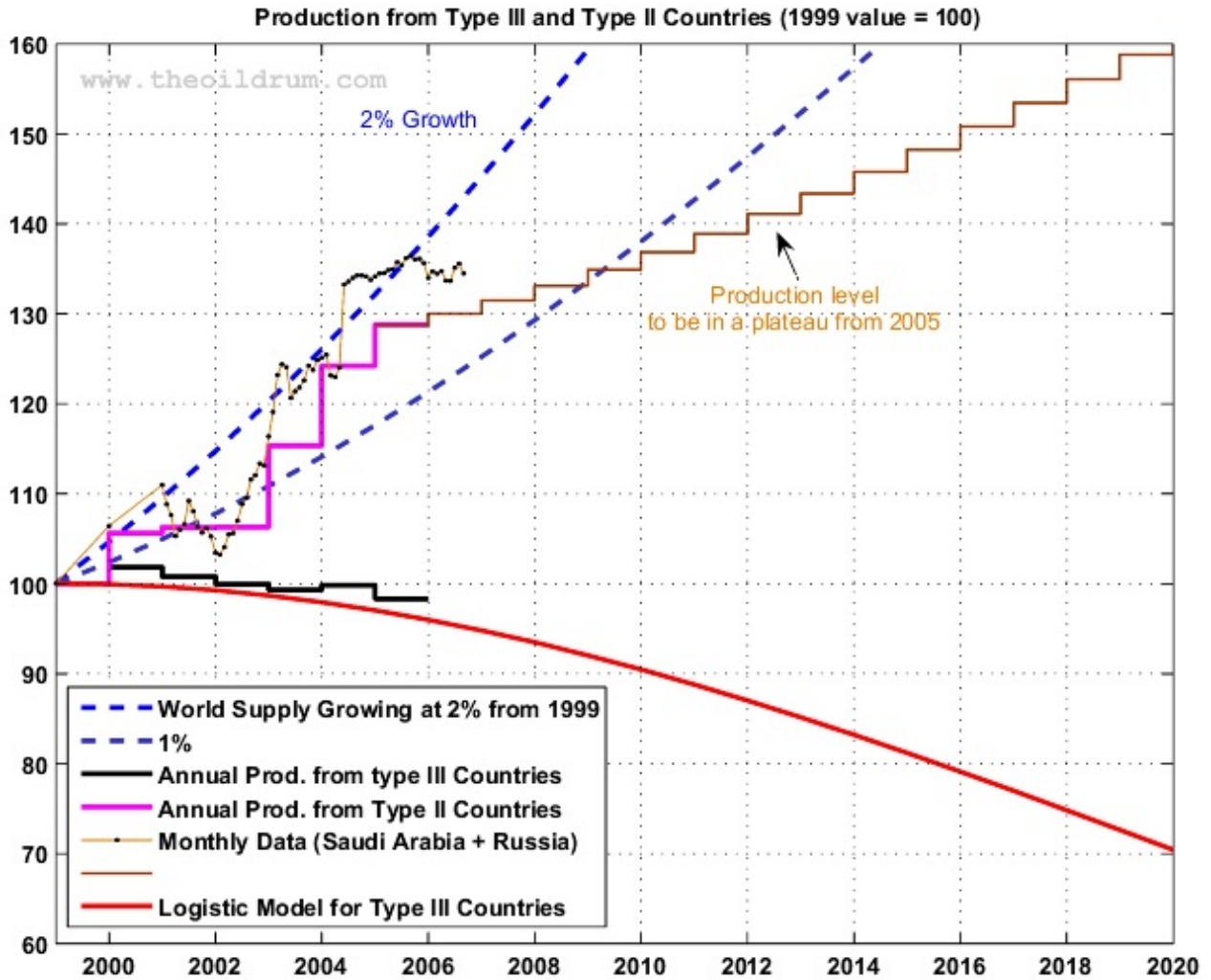


Fig. 10- Production growth and decline within group II and III. The two dotted blue lines represents the new supply from the type II group that is required to meet the world demand growth.

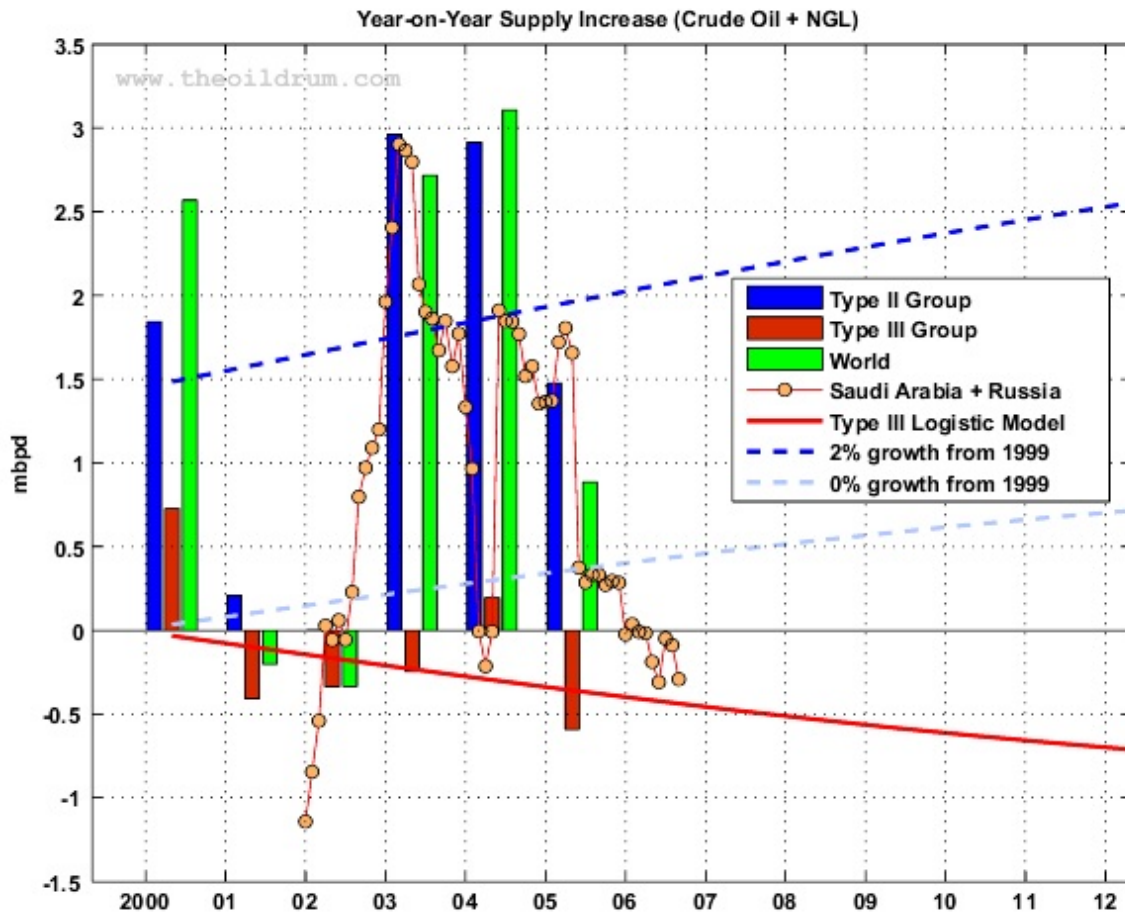


Fig. 11- Yearly supply fluctuations in mbpd. The two dotted blue lines represents the new supply from the type II group that is necessary to meet the world demand growth.

	1999	2005	2006	2007	2010	2012	2015	2020
Group III (Observed)	39.78	39.11						
	-2.20%	-1.49%						
Logistic Group III	40.32	39.12	38.70	38.23	36.48	35.10	32.76	28.43
	+0.08%	-0.91%	-1.07%	-1.23%	-1.70%	-1.99%	-2.41%	-3.04%
Logistic Group III+Canadian Tar Sands	40.32	39.17	38.97	38.73	38.31	37.76	35.93	32.07
	+0.08%	-0.80%	-0.52%	-0.61%	-0.11%	-0.80%	-1.84%	-2.29%
World CO + NGPL (Observed)	72.50	81.25	81.20*					
	-1.68%	+1.10%	-0.06%*					
CO + NGPL (1.5% Growth from 1999)	72.50	79.28	80.47	81.68	85.41	87.99	92.01	99.12
		+1.50%	+1.50%	+1.50%	+1.50%	+1.50%	+1.50%	+1.50%
Group II (Observed)	32.72	42.13						
	-	+12.60%						

	1.04%	+3.03%						
Group II (Requirement¹)	32.18	40.15	41.76	43.45	48.92	52.89	59.25	70.69
		+3.97%	+4.01%	+4.03%	+4.02%	+3.96%	+3.80%	+3.45%
Group II + Tar Sands (Requirement¹)	32.18	40.11	41.50	42.95	47.10	50.23	56.08	67.05
		+3.85%	+3.47%	+3.48%	+2.85%	+3.30%	+3.76%	+3.42%
Russia (Observed²)	6.31	9.50	9.59 [*]					
		+2.59%	+0.94%					
Saudi Arabia (Observed²)	8.84	11.01	10.79 [*]					
		+5.76%	-2.02%					

Table III - Observed and projected production values (in mbpd) for Crude Oil + NGL. The second row for each category gives the decline rate (or growth rate) in percent for the considered year.¹ in order to satisfy the target of 1.5% annual growth for the world production. ²Data taken from the last International Petroleum Monthly (EIA). ^{} Early estimates (8 months).*

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