2do SIMPOSIO ASPO ARGENTINA Buenos Aires, 13 de mayo de 2010
"Peak Oil y Seguridad Energética"

Peaks in Argentina, Latin America and the world

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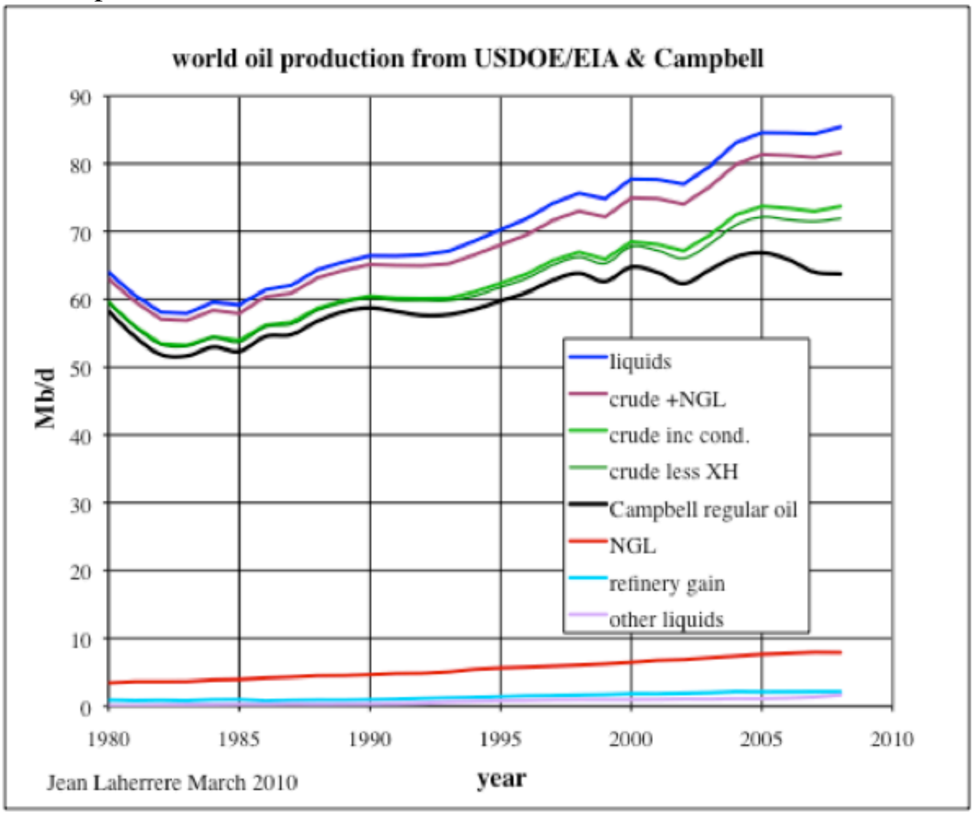
-World oil peak or bumpy plateau?
Oil peak or peak oil?
Peak oil was introduced first by Colin Campbell in an article in 2001, then by the creation of ASPO (peak oil was preferred because ASPO sounds better than ASOP)

Oil is often not properly defined and can vary from 64 to 86 Mb/d depending upon definition or sources
Figure 1: world oil production with different definitions

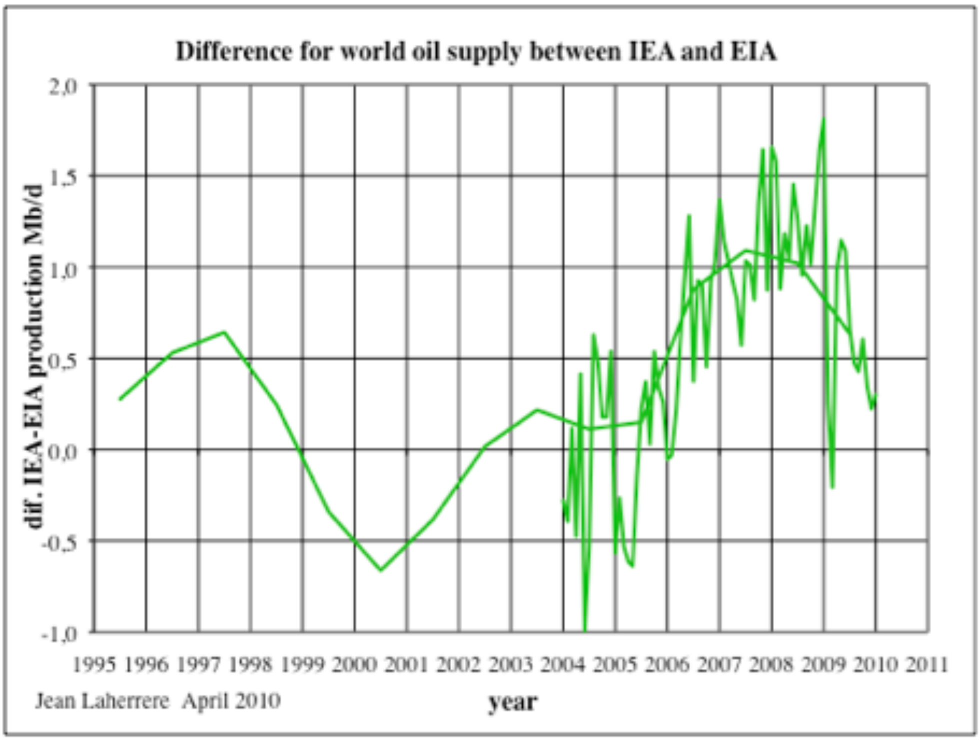


The best sources are:
-USDOE/EIA, best because available on the web, corrected from time to time and covering a every country and energy source
-IEA International Energy Agency (the consumers' club) whose data is in disagreement with EIA (see below) mainly for biofuels and NG liquids
-OPEC (the producers' club), but because their members cheat on quotas, their production data is questionable
-BP Statistical Review with a good historical file, but reporting what national agencies report
The 2008 oil production varies from 64 Mb/d for the regular oil of Campbell to 86 Mb/d for all liquids, but ridiculous values with many significant digits are reported

World oil production for 2008	definition	Mb/d
OGJ Oil & Gas Journal	oil	72,647
WO World Oil magazine	crude/condensate	74,698 0
BP Statistical Review	liquids (excl BTL, CTL)	81,663 310 979 140 2

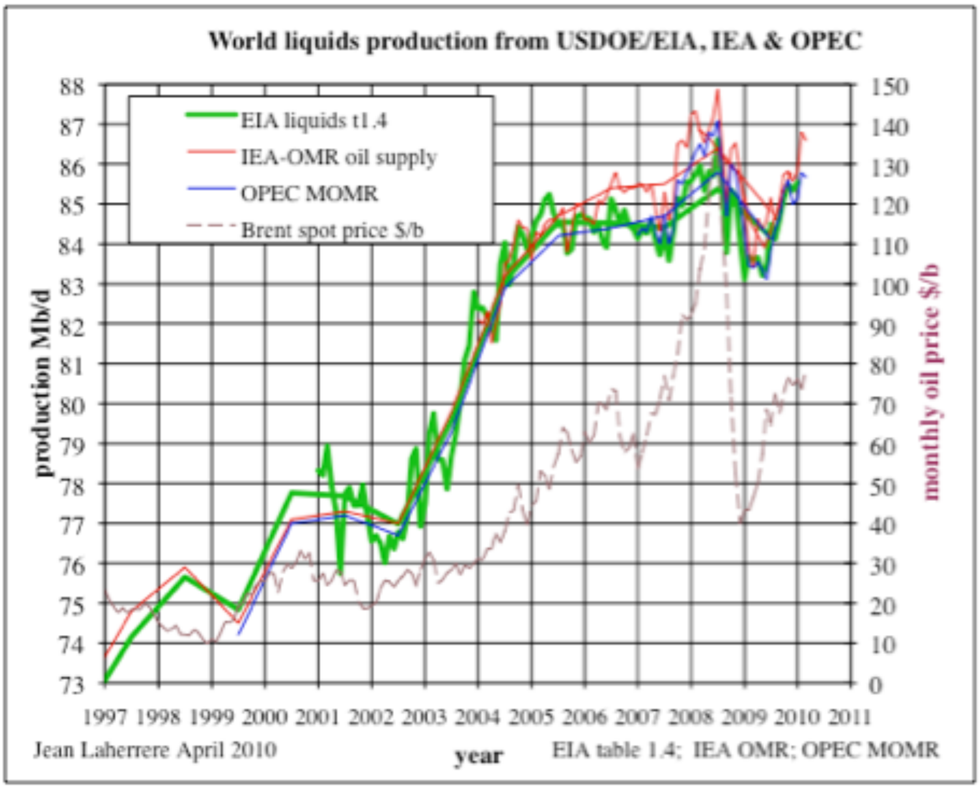
USDoE (Depart of Energy)/EIA	crude oil	73,573 844 712 166 8
	all liquids	84,597 461 4
IEA International Energy Agency	oil	85,4
OPEP	crude oil	72,028 3
	oil supply	86

The difference for oil supply between EIA and IEA varies and can reach 1,5 Mb/d and any enquiry addressed to those agencies could not precisely get any answer, except that they deal with heterogeneous (volume or weight without knowing the gravity) and incomplete data (condensate, NGL, biofuels) from national agencies and their methods of compilation differs. In IEA WEO 2008, NGL is taken for 2008 as 10 Mb/d, when EIA value is less than 8 Mb/d!
Figure 2: world oil supply: difference between IEA and EIA



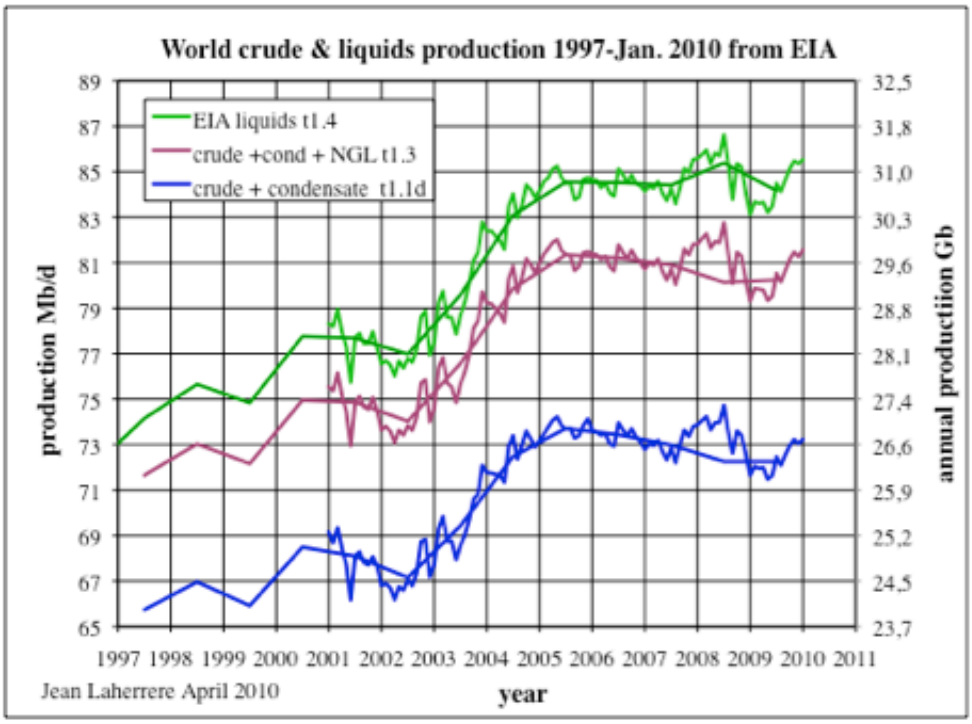
It means that the **accuracy of the world oil supply is about 2 Mb/d (2.5 %).**
Any fluctuation of a bumpy plateau below 2 Mb/d is not significant!

A driver filling up his car at the service station does not know the amount of biofuels included in the gasoline.
Oil demand includes biofuels, and then, oil supply, which is assumed to fill the demand, should include all liquids.
The world liquids monthly and annual production from EIA, IEA and OPEC differs largely.
Figure 3: world oil monthly supply from different sources



In order to deal with the peak, it is necessary to see the evolution from one source, and the best source is EIA.

Figure 4: world liquids and crude oil production from EIA



For crude oil (including condensate) the annual peak took place in 2005 and the monthly peak was in July 2008

For all liquids the peak is July 2008 (Chinese fill-up before the Olympic Games), but it is obvious that it is more a bumpy plateau than a Hubbert peak. The question is whether new developments of new discoveries and yet-to-find oil will overcome the decline of the present producing fields!

For that it is necessary to estimate the ultimate reserves (which represent the cumulative production at the end of production)

-World oil discovery and production

-Remaining oil reserves

Discovery is helpful to estimate the ultimate, when the value of field reserves is the mean (2P) backdated value. The current proved remaining reserves reported by IOCs to comply with the obsolete SEC rules are useless because the mathematical aggregation of proved reserves is wrong and because operators decide development on Net Present Value based on mean value of the field reserves, and only mean field values can be added to get the mean value of the country or the world. Most reserve growth is due to this poor US practice. The SEC has changed their reporting rules for 2010, recognizing that their rules were wrong before.

The NOCs proved reserves are political, being the base of the quotas and every OPEC member cheats on quotas and reserves, which are not audited. Only Kuwait did an audit at the request of the Parliament after an article of PIW saying that Kuwait proved reserves were twice too high. It is rumoured that the audit confirms the PIW statement, but it is confidential.

The problem is that statements by national agencies cannot be challenged by another official agency from another country without implying diplomatic incident. It is now the same with scout databases; which now have NOCs as clients!

After the counter shock of 1986 when OPEC quotas were installed, Kuwait increased their reserves by 50%, followed by Iran, then Iraq and others, the last one being Saudi Arabia. But the Neutral Zone (owned 50/50 by Kuwait and Saudi Arabia) did not increase its reserves!

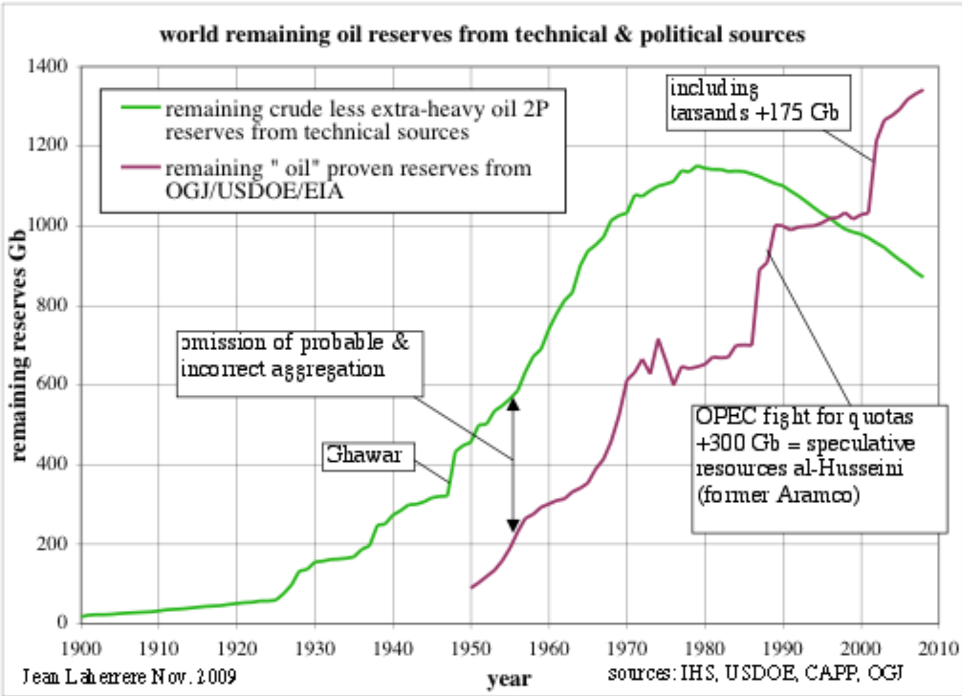
From 1986 to 1989 300 Gb were added to OPEC reserves without any major discovery. This 300 Gb increase was stated as political by ASPO for a long time, but as real reserve growth by many. It is only in 2007 in London that Sadad al-Husseini, former Aramco VP (retired by his minister because believing in peak oil) stated that this 300 Gb increase was speculative resources, unlikely to be produced.

The political (OPEC) or financial (SEC) remaining reserves have been increasing since 1950 and in 2001 OGJ added the tarsands, when, before, only conventional reserves were reported.

It is well known that oil discovery is less than oil production since 1980, and thus remaining reserves should decrease.

But economists have only access to political reserves as reported by USDOE and BP Statistical Review. Economists do not think wrong, they think on wrong data!

Figure 5: world remaining reserves from technical (confidential) and political (public) sources



-Crude les extra-heavy (XH) oil

Technical data reporting 2P (proved + probable) reserves comes from scout companies, which sell their database for an expensive amount, because involving a very large number of fields (over 25 000 fields).

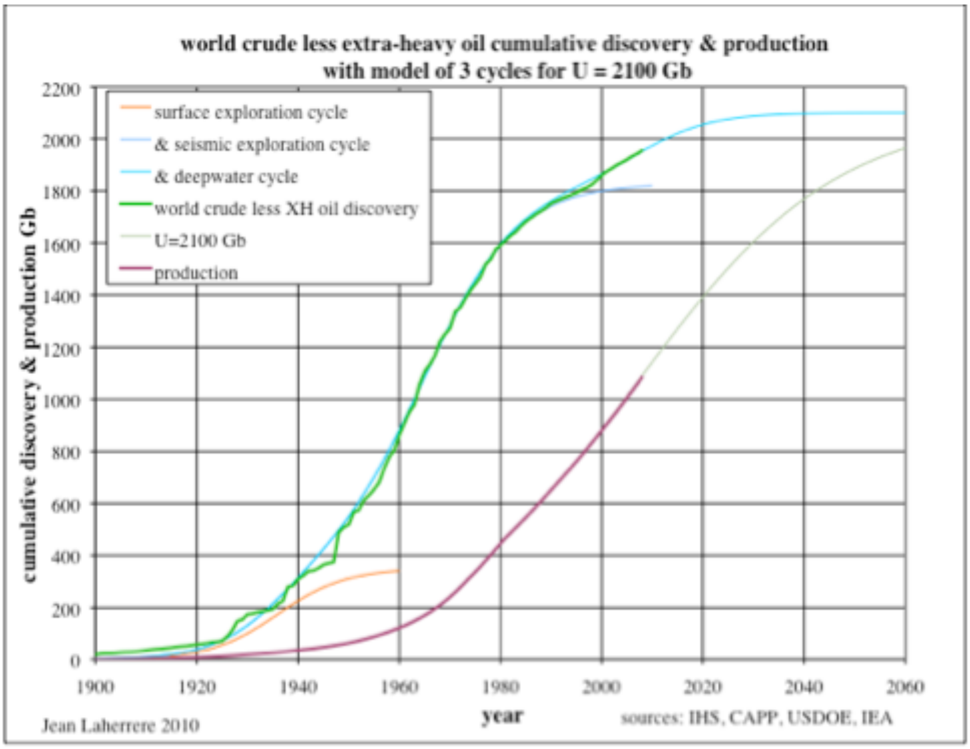
Technical databases were at the beginning compiled by geologists without being disturbed by political constraints, however now they are obliged to report what NOCs report, because now NOCs are their clients!

It is then necessary to correct these technical data from OPEC overestimated reserves, but also the FSU reserves estimated as ABC1 = 3P by a now obsolete Russian classification using a maximum theoretical recovery factor. Recent audits of Gazprom confirm that ABC1 reserves should be reduced by 30% to obtain 2P reserves.

After correction to OPEC and FSU reserves to obtain 2P (mean) estimates which can be added (contrary to proved reserves) and removing discovery of extra-heavy (XH) oil in Venezuela, the following cumulative discovery can be modelled with 3 cycles, being surface exploration, then seismic exploration and lately deepwater exploration.

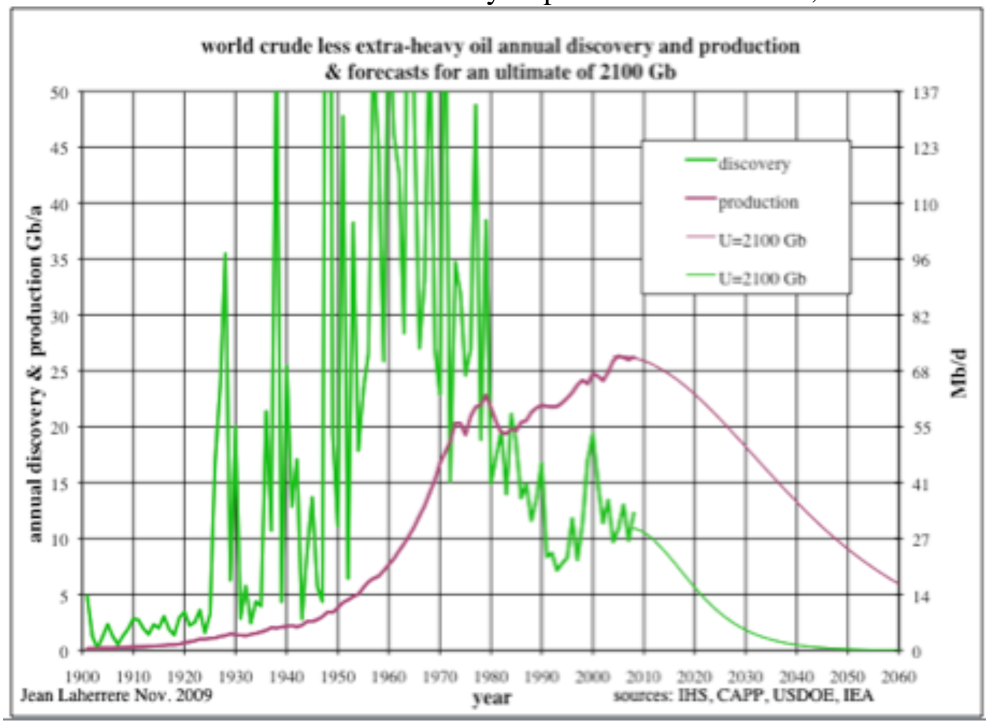
The ultimate of this crude less XH oil is 2.1 Tb. Up to now I was using a round value of 2 Tb, but now I feel that I can add a second digit and be more precise.

Figure 6: world crude less XH oil cumulative discovery & production for U = 2,1 Tb



The same data is plotted as annual discovery and production of crude less XH oil. Discovery peak was in the 60s, production peak likely in the 2000s.

Figure 7: world crude less XH oil annual discovery & production for U = 2,1 Tb

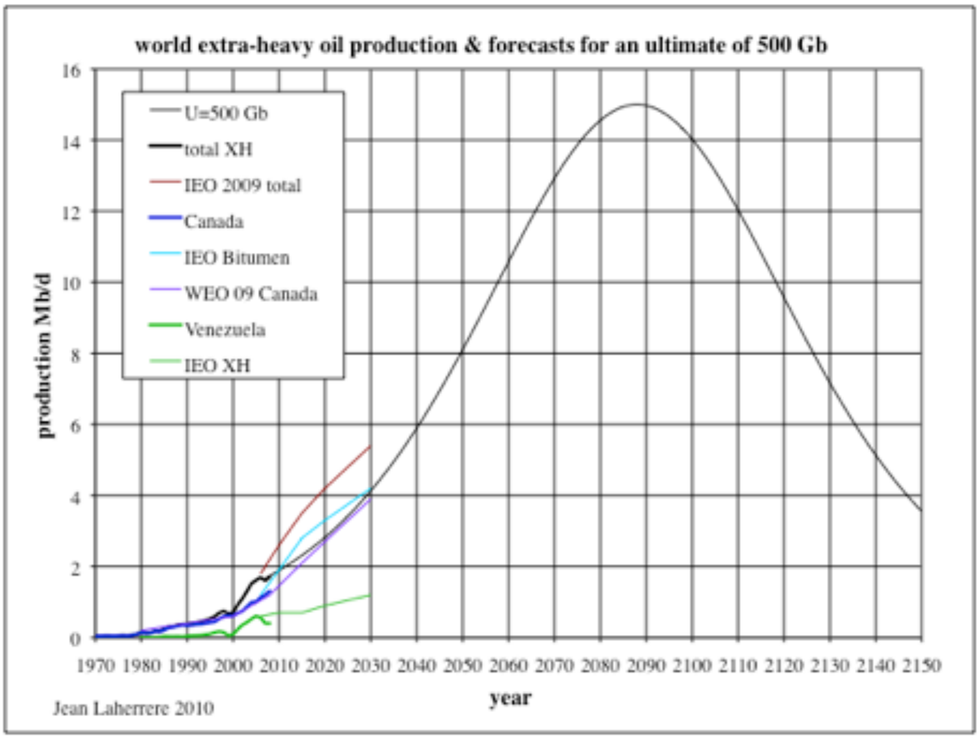


-Extra-Heavy oil

The XH oil production comes only from Canada and Venezuela, but if the data for Canada is good and complete (CAPP database), Venezuela recent production data is poor and incomplete. The world ultimate of XH is taken as 500 Gb. **The problem with unconventional is that the size of the tank does not matter, it is only the size of the tap**. Unconventional oil needs very large investment and the production needs a lot of water and steam, creating pollution. Above ground constraints are important. The XH peak will be in the end of the century around 15 Mb/d.

Production increase could be sharper, but environment problems will prevail until needs overcome them!

Figure 8: world extra-heavy oil production for U = 500 Gb

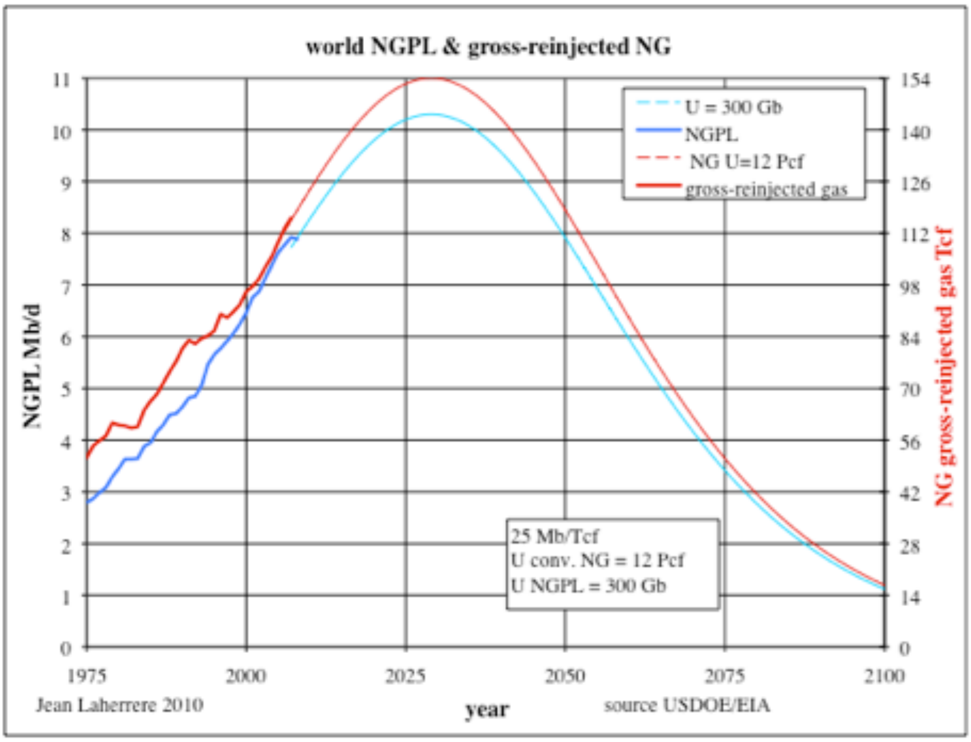


-Natural gas liquids

Condensate being included in crude oil in EIA data, the natural gas plant liquids (NGPL) follows the production of gross–reinjected NG conventional production.

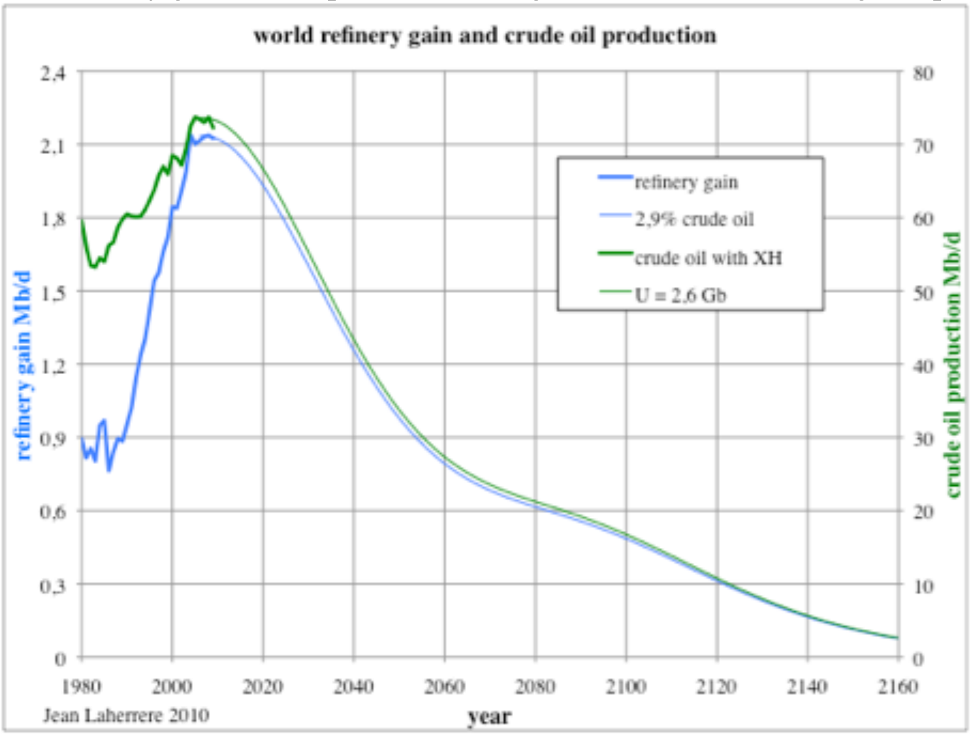
NGPL ultimate is 300 Gb and the peak in 2030 as NG peak

Figure 9: world NGPL production for U= 300 Gb related to NG (gross-reinjected) production



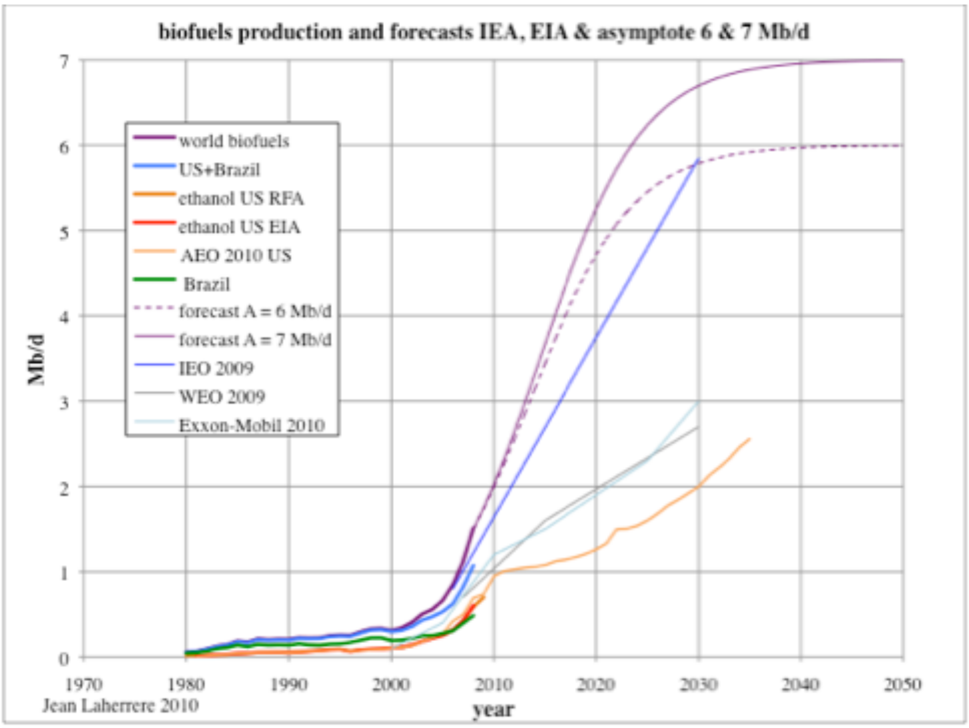
-Refinery gain

Refinery gain (to obtain lighter product, refineries use cracking and hydrogenation) is presently about 2 Mb/d, more than XH! Refinery gain is related to crude (including XH) production being presently 2.9 % of its production. We assume that this ratio will remain and that refinery gain peak is now. EIA AEO 2009 forecasts, for 2030, a refinery gain between 2.1 and 3.2 Mb/d, but this 3.2 Mb/d is part of a low oil price oil scenario at 119.3 Mb/d, recognized by many as unrealistic!
The ultimate of refinery gain should be around 60 Gb.
Figure 10: world refinery gain annual production being 2.9 % of crude including XH production



-Biofuels

The discrepancy between IEA and EIA past oil production is mainly due to biofuels; it is likely to be the same for biofuels forecasts.
For 2030 WEO 2008 forecasts 2.7 Mb/d, when EIA forecasts 5.9 Mb/d and Exxon-Mobil 3 Mb/d!
Contrary to oil, which is limited in reserves, biofuels are renewable, but its production is limited by the area of arable surfaces, and also by the peak of phosphate around 2040 (see figure 66).
The EROEI of ethanol from corn is below one, according to several university studies (Pimentel, Patzek, Chavanne). Most biofuels require subsidies. Second generation biofuels are still at research level and no sign of commercial pilot.
We assume that the maximum of renewable is about 6 to 7 Mb/d because biofuels are in competition with food in a world where population is still growing and hungry.
Figure 11: world biofuels annual production assuming an asymptote of 6 & 7 Mb/d



-XTL (in fact without biofuels)

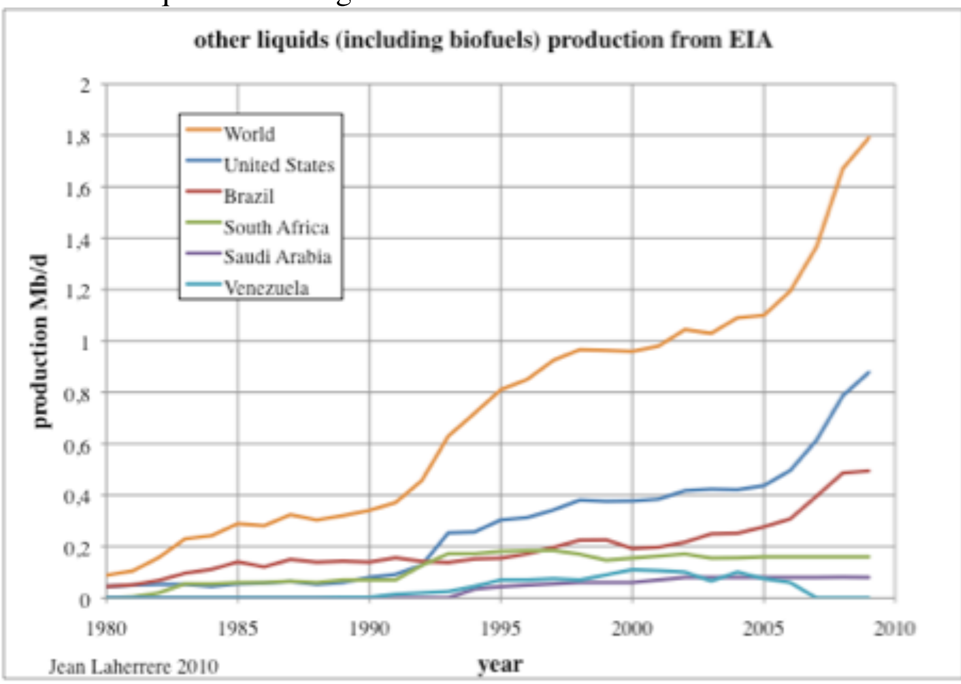
XTL is *X to liquids* and gathers CTL (coal), GTL (gas), BTL (biomass), STL (shale), HTL (hydrogen)

In this paper, XTL is used as a limited term where biofuels is excluded and represents the difference between all liquids and the sum crude +NGPL +refinery gain + biofuels.

It is very small being only CTL+GTL +synthetic oil (orimulsion or MTBE) at 0,1 Mb/d in 2008.

In this definition XTL = other liquids from EIA less biofuels

Figure 12: world other liquids including biofuels from EIA

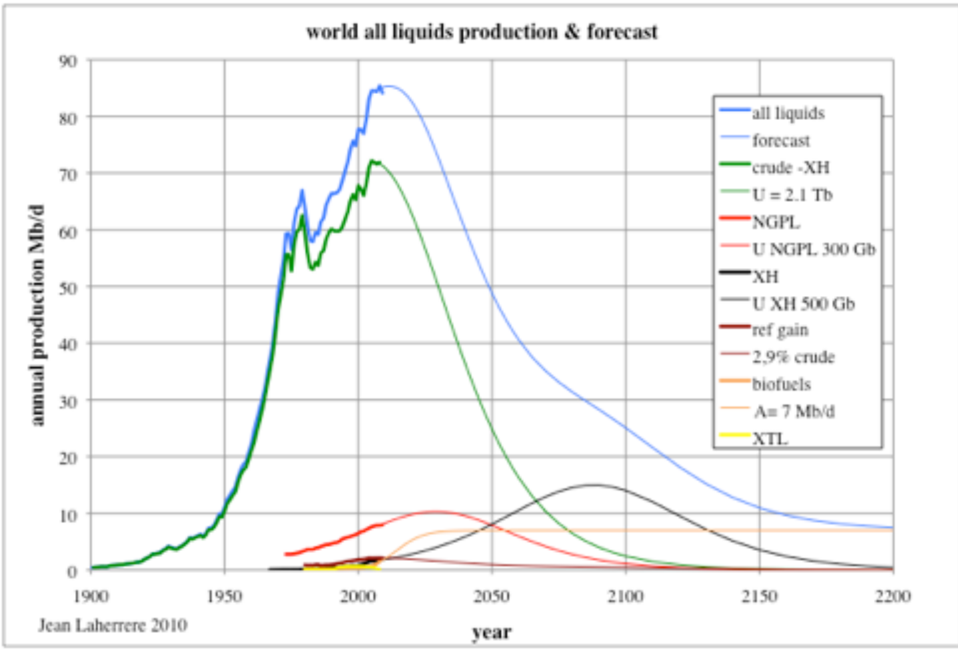


-All liquids

The all liquids forecast is obtained by adding all items, except XTL (anyone can add what he thinks) because presently XTL is much less than oil supply accuracy (2 Mb/d).

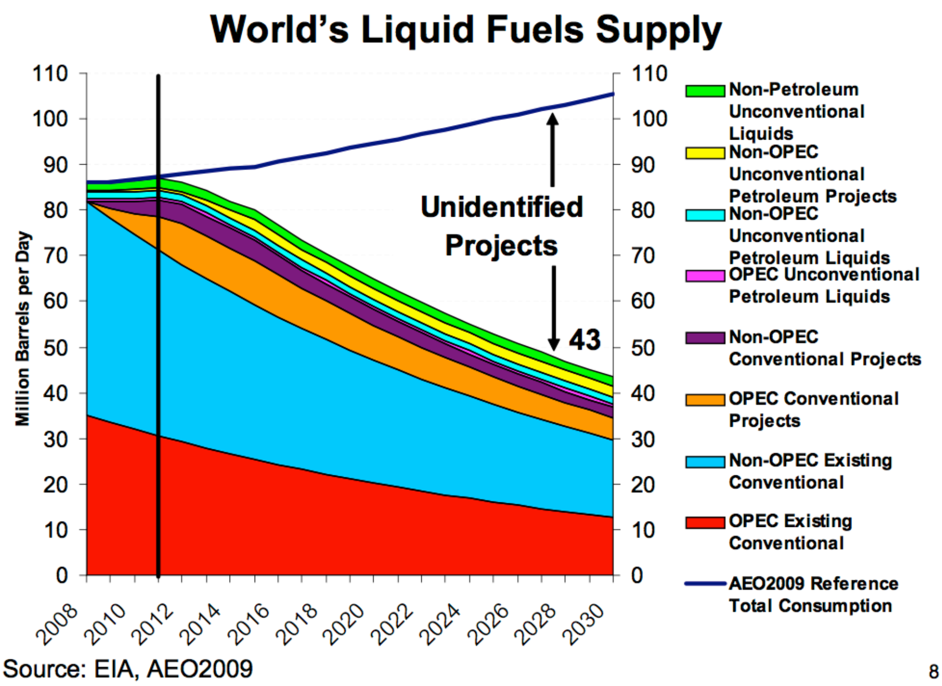
This forecast assumes no constraint above ground, only constraints from below the ground.

Figure 13: world all liquids production and forecast for an ultimate of 3 Tb + biofuels asymptote at 7 Mb/d, assuming no above ground constraint



Above ground constraints can change the above forecast plot, but the area below the curve should stay the same, if the ultimate estimate is right!

The asymptote of biofuels could be increased to 10 Mb/d and this will not change much the all liquids decline, only after 2150!
My guess for 2030 is 70 Mb/d, but Sweetnam USDOE 2009 forecasts less than 50 Mb/d for the identified projects. The production of the next 10 years will come from identified projects
Figure 14: world's liquids supply from USDOE/EIA = Sweetnam 2009



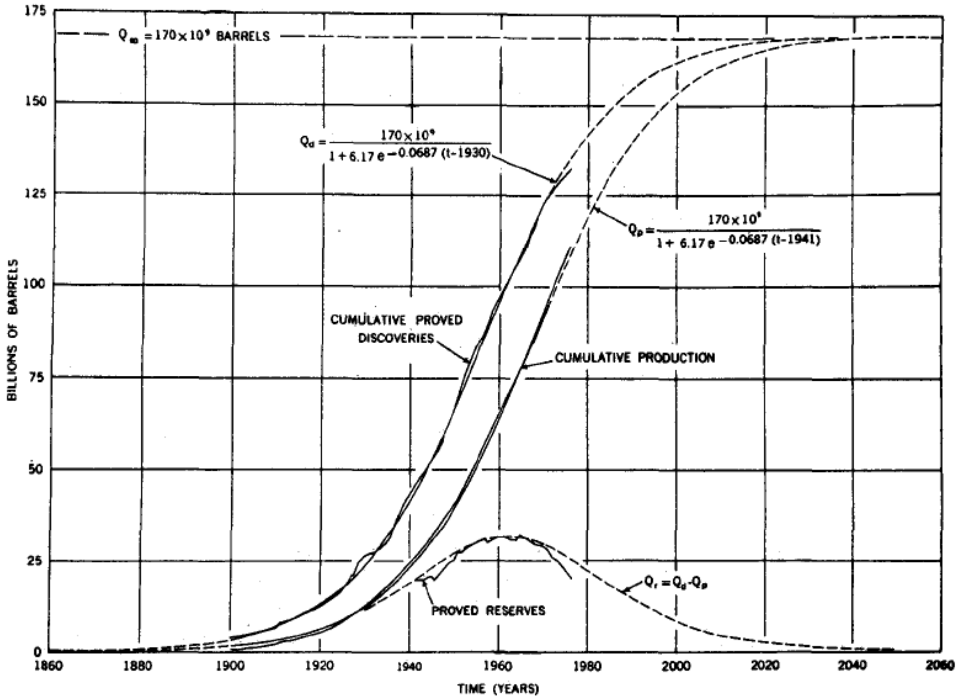
For EIA 2009, the non-conventional is less than 10 Mb/d in 2030 outside unidentified projects.
The GOM giant (1 Gb) oilfield Thunder Horse decline is worse than expected (25%)!
The blow out of Deepwater Horizon semi-sub shows that safety in deepwater high pressures conditions is less secured than conventional conditions, making unconventional much more difficult and expensive.

The so-called "reserve growth" claimed by the USGS is likely to be negative!

-USL48 oil discovery & production

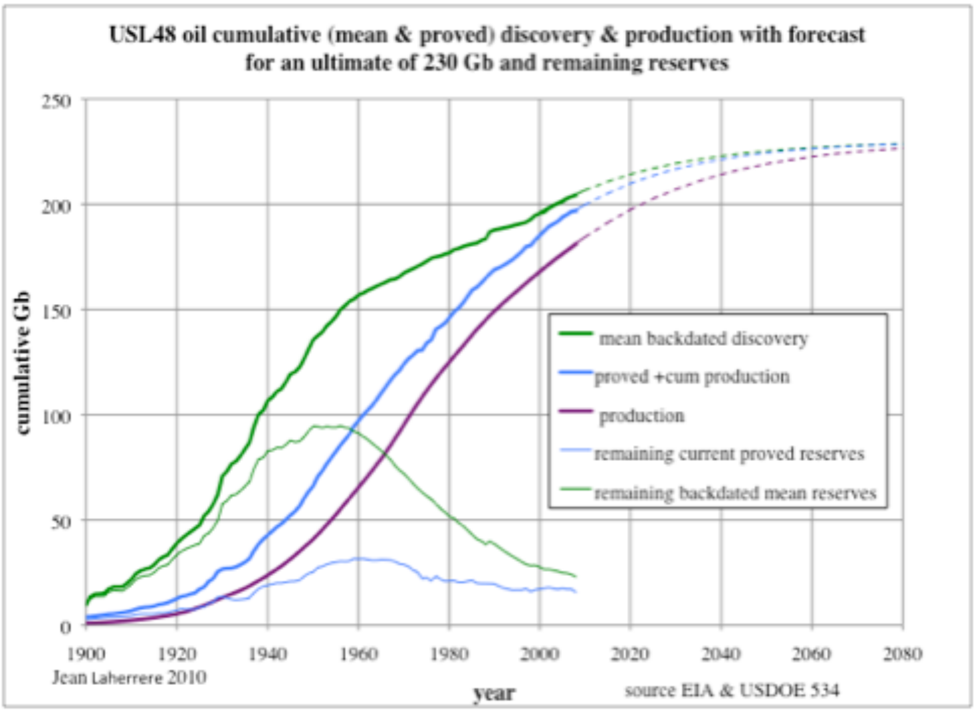
King Hubbert forecasted in 1956 that the USL48 oil production would peak in 1965 (U=150 Gb) or in 1970 (U=200 Gb). USL48 oil production peaked in 1970, but in 1981 («The world 's evolving energy system» Am. J. Phys. 49-11) Hubbert was still believing that USL48 ultimate was 170 Gb.

Figure 15: USL48 oil cumulative discovery & production at end 1977 from Hubbert 1981

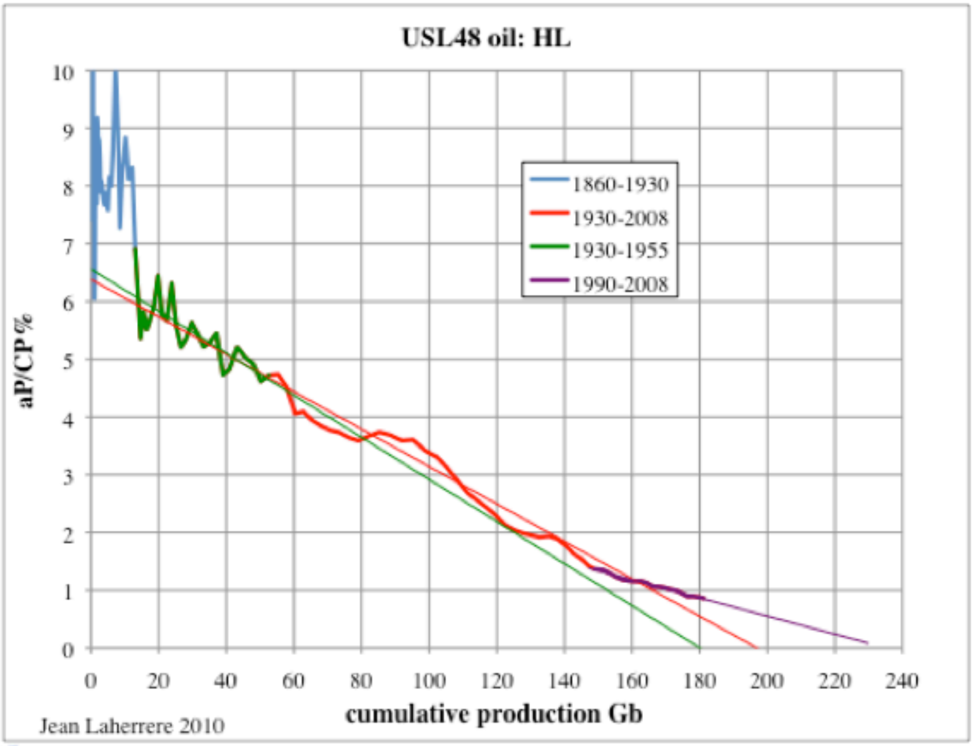


The data at end 2008 is different: proved and cumulative production is close to 200 Gb and the ultimate from mean backdated reserves seems to be 230 Gb.

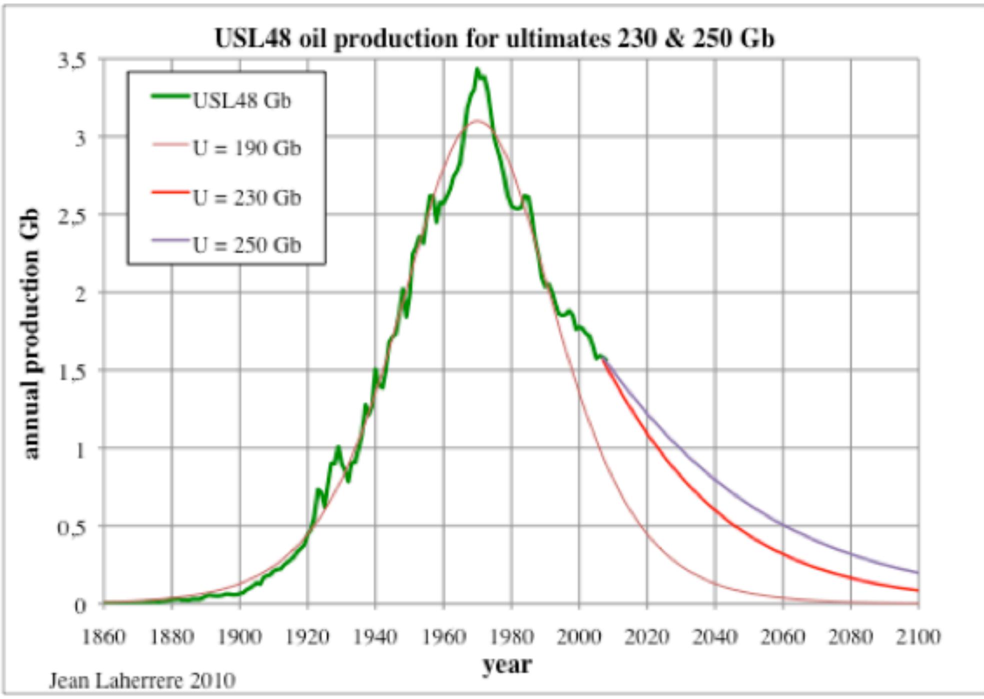
Figure 16: USL48 oil cumulative discovery & production with 230 Gb ultimate



The Hubbert linearization plot (% annual production/cumulative production versus cumulative production) shows often several successive linear trends. For the USL48, Hubbert could have taken 180 Gb for the period 1930-1955, for the period 1990-2008 (deepwater) the ultimate is 230 Gb.
Figure 17: USL48 Hubbert Linearization 1860-2008



USL48 oil annual production from 1860 to 1990 displays an amazing symmetrical curve, but with a sharp peak. The symmetry can be explained by the fact that US oil is produced by more than 20 000 producers who act independently (at random = law of large number = Brownian pattern = Gauss curve). It is confirmed by the fact that, in the end of the 50s, proration obliges producers to act the same way and, in the beginning of the 80s, the high oil price pushes producers to produce at the maximum: it is why, on these two short periods, the random rise and the random decline were disturbed. Since 1990, deepwater producers are not very many and they all work to produce at the maximum rate, because the high costs of deepwater platforms.
Using an ultimate of 230 Gb (and 250 Gb for subsalt potential), the future production displays an unsymmetrical pattern.
Figure 18: USL48 oil annual production for ultimates 230 & 250 Gb



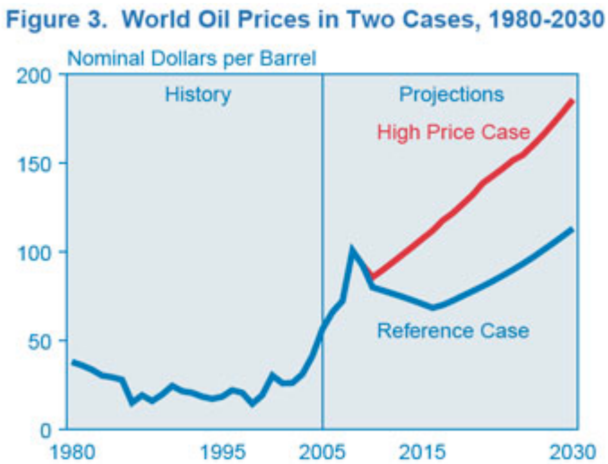
-Chaotic oil price: peaks and valleys

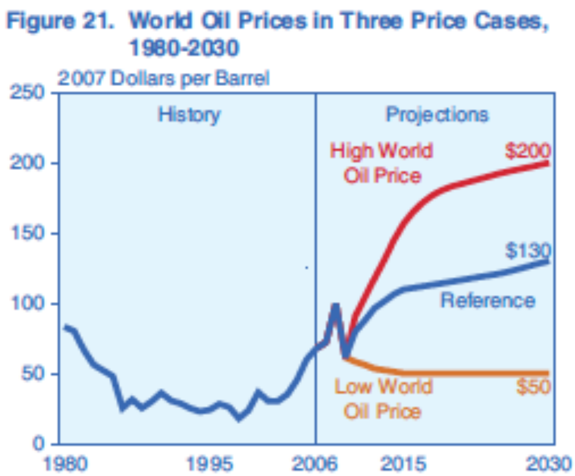
Oil price forecasts in the past have been almost always wrong in drastic manner!

USDOE forecasts up to 2030 were different in 2008 compared to those in 2009

Figure 19: oil price forecasts 1980-2030 from USDOE in 2008 and 2009

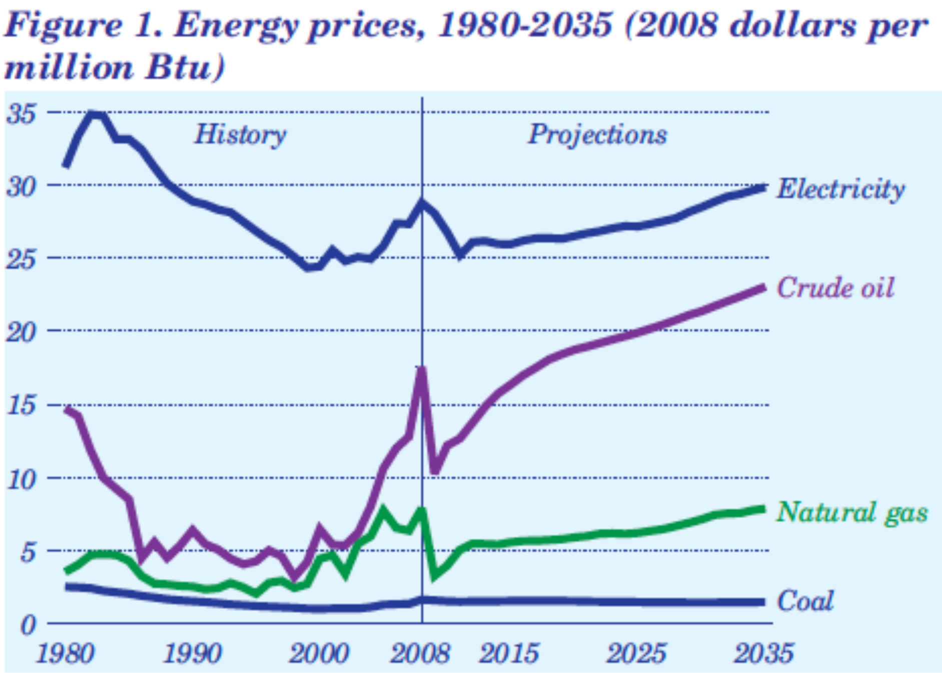
IEO2008 $ reel IEO2009 $2007



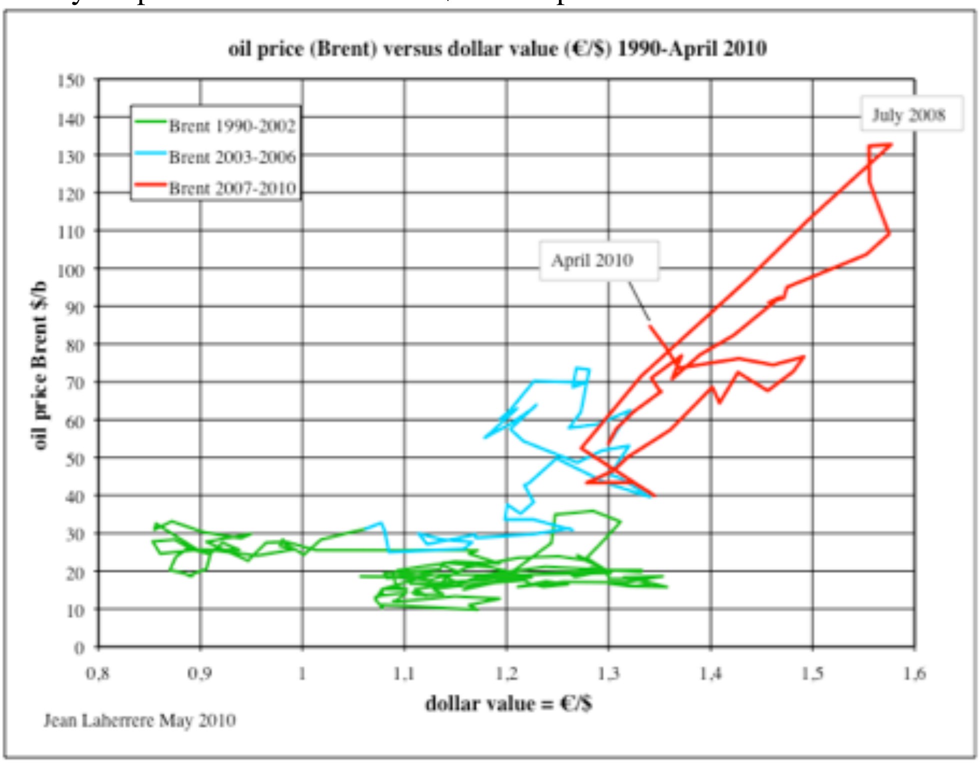


In AEO 2010, EIA forecasts the world energy price where, in 2035, crude oil price will be closer to electricity and about three times that of natural gas.

Figure 20: energy price forecasts from USDOE AEO 2010 in $2008/MBtu

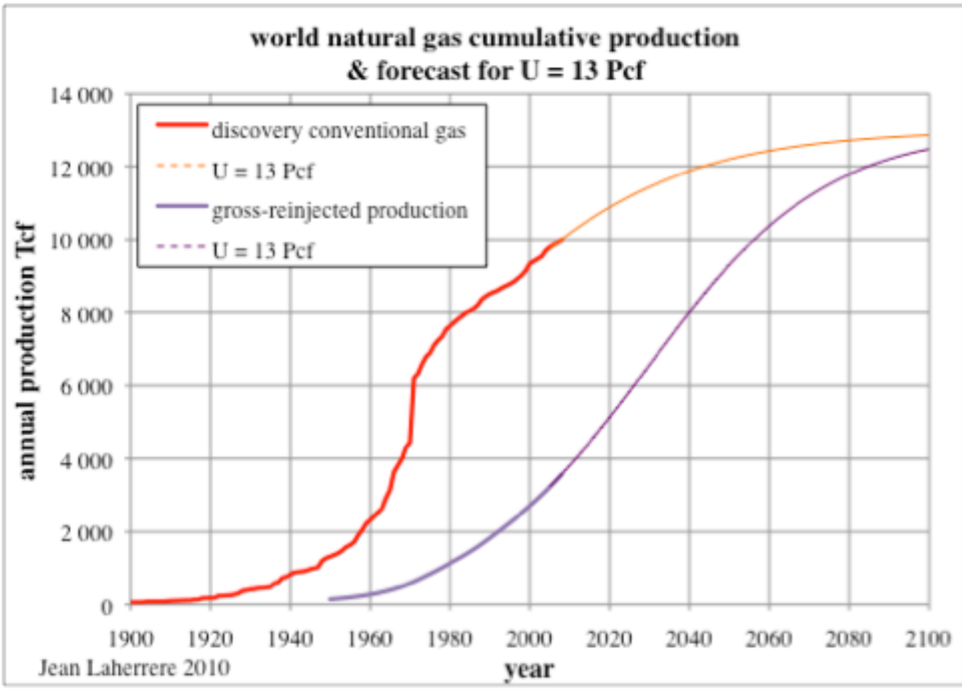


The plot of oil price versus the dollar value (€/$) shows that the dollar value had no impact on oil price from 1990 to 2002, but started to have some from 2003 to 2006.
There is a strong linear relationship from 2007 to now.
The oil price in March 2010 at 79 $/b & 1.36 €/$ is close to October 2008 at 72 $/b & 1.33 €/$ or September 2007 at 77 $/b & 1.39 €/$. The peak of July 2008 (fill up for China OG) is 133 $/b is for 1.58 €/$.
How long will this relationship prevail?
Figure 21: monthly oil price versus dollar = €/$ for the period Jan. 1990-March 2010

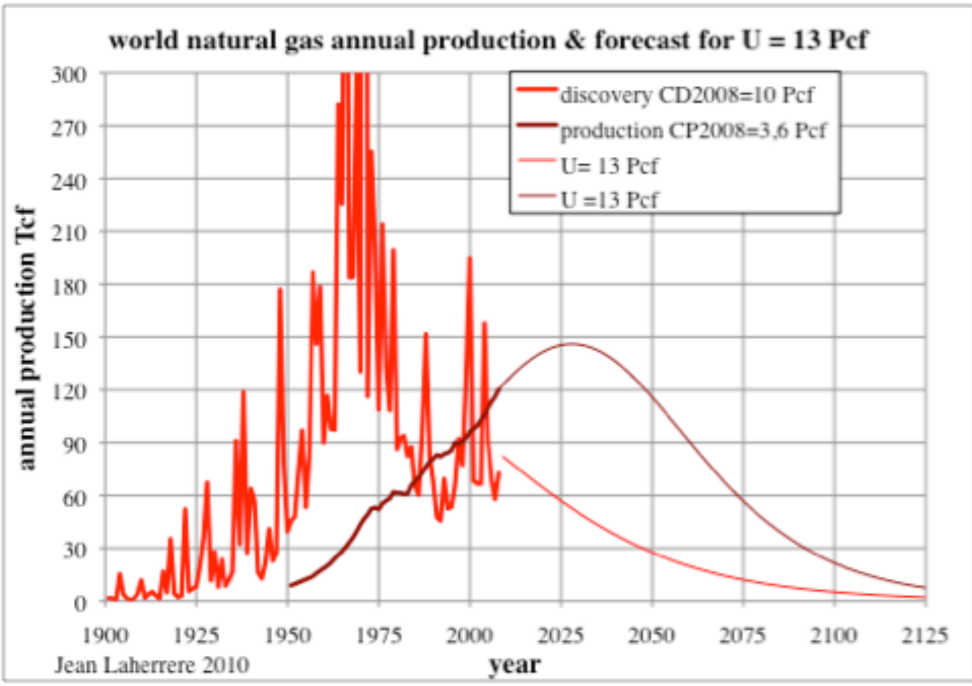


-Natural gas

Because there is no OGEC and no quotas, the NG reserves are less polluted by politics, only FSU ABC1=3P data need to be corrected.
At end of 2008, the cumulative NG conventional discovery is around 10 Pcf and cumulative production at 3.6 Pcf. The NG ultimate is taken at 13 Pcf.
Figure 22: world natural gas cumulative discovery & production for U= 13 Pcf



The same data is plotted for annual production
Figure 23: world natural gas annual discovery & production for U= 13 Pcf



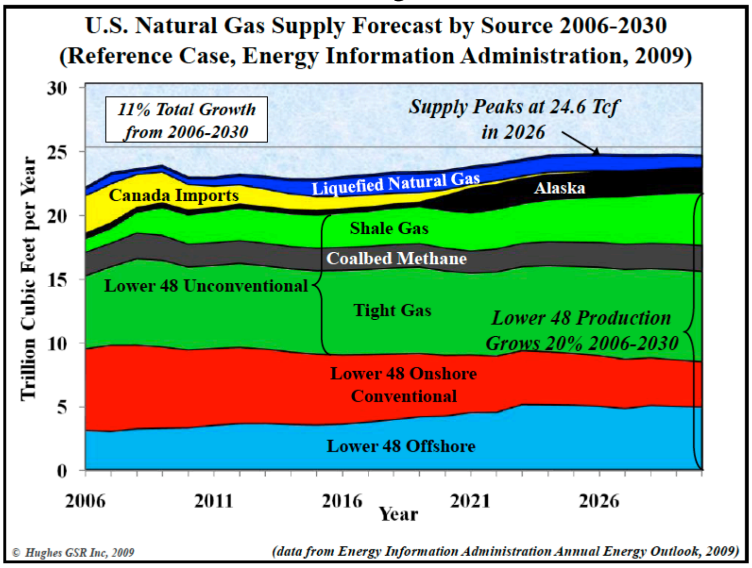
The world NG discovery peaked in the 70s and the production peak will be in the 2020s.

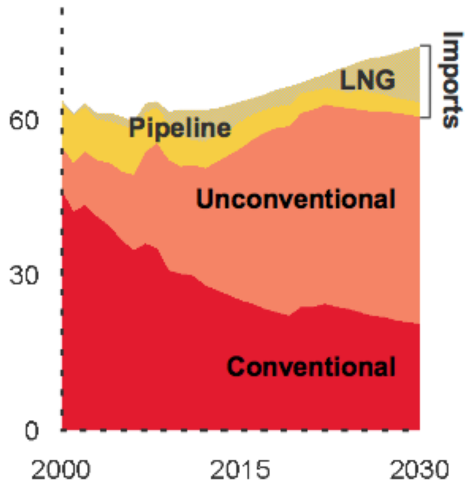
-Shale gas

Shale gas is found in source-rock with poor reservoir quality, but it not new. The first US gas production was in 1820 at Fredonia in New York State from Marcellus shale gas. But shale gas was abandoned when conventional, easy, cheap gas was found. The ghost is back with new technology!

Shale gas production was busted by horizontal wells and fracturing, promoted by small independent when gas price went up to more than 10$/kcf. The area of the basins with shale gas is huge (area of the source-rock) and gas is found everywhere in this continuous-type accumulations, but the quality of the reservoir is heterogeneous. Yet most operators assume that good quality reservoir (sweet spot) will prevail in most of the basin, though it is likely not to be the case. Now with horizontal drilling and hydraulic fracturing, higher initial production occurs (the cost is also higher), but the decline is also sharper. But the US gas price went down from 12 $/kcf to 3 $/kcf and the number of shale gas rigs was reduced by half. There is disagreement on the economic threshold of shale gas.

The US gas supply forecasts differ largely between J.D. Hughes («Natural gas in North America: a panacea to replace imported oil?» Sept 2009) displaying the forecast of EIA AEO 2009 and Exxon-Mobil Eizember 2010 «The outlook for energy: a view to 2030»
Figure 24: US natural gas forecast to 2030
from AEO 2009 via Hughes in Tcf from Exxon-Mobil 2010 in Gcf/d





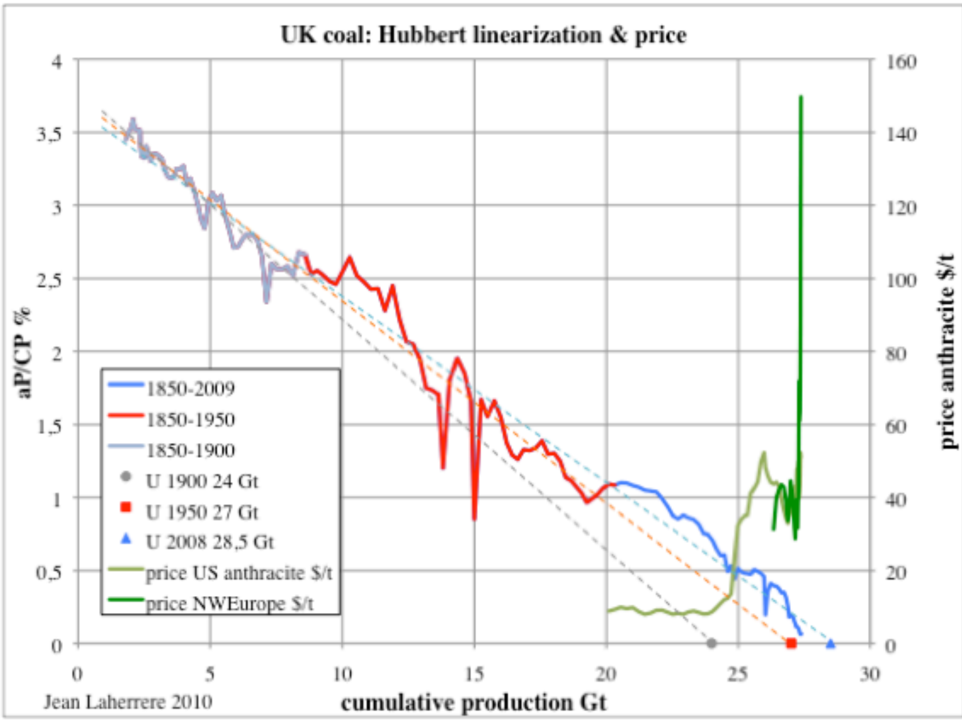
In 2030 the increase in US shale gas could be less than the inaccuracy on the conventional gas forecast decrease. Tight gas, formerly included in unconventional by EIA, is now conventional in AEO 2010, when some gather together tight gas and shale gas! It appears that transparency is not the goal of many! Confusion helps promotion!
There is large disagreement on the life of the shale gas wells. Chesapeake claims several decades when some (Berman) only a few years. Shale gas real production started few years ago and more than ten years production is needed to have enough data to judge the long-term behaviour of shale gas wells. We have to wait a few years to know more about shale gas potential. We have to remember the hopes on CBM potential (now flat) in the 90s, in dissolved gas in geopressured aquifers in the 80s (little production despite resources up to 50 000 Tcf BGR 2003), and tomorrow in the hydrates!
But the main problem of shale gas is the possible pollution of the large injected volume of water with toxic (confidential) products (biocides) in deep aquifers, which can move from faulty (or simply old) wells into shallow drinking aquifers, but it will take some time! New York State forbids shale gas drilling. NIMA (Not In My Aquifer) soon could be as strong as NIMBY! Injecting high-pressured water volume may also lead to earthquake, as happened in Switzerland for the dry rock geothermal pilot, now stopped.

-Coal
Oil and gas future production are modelled using ultimate value estimated from field data reserves. Oil & gas conventional accumulations are discrete fields, when unconventional fields are the

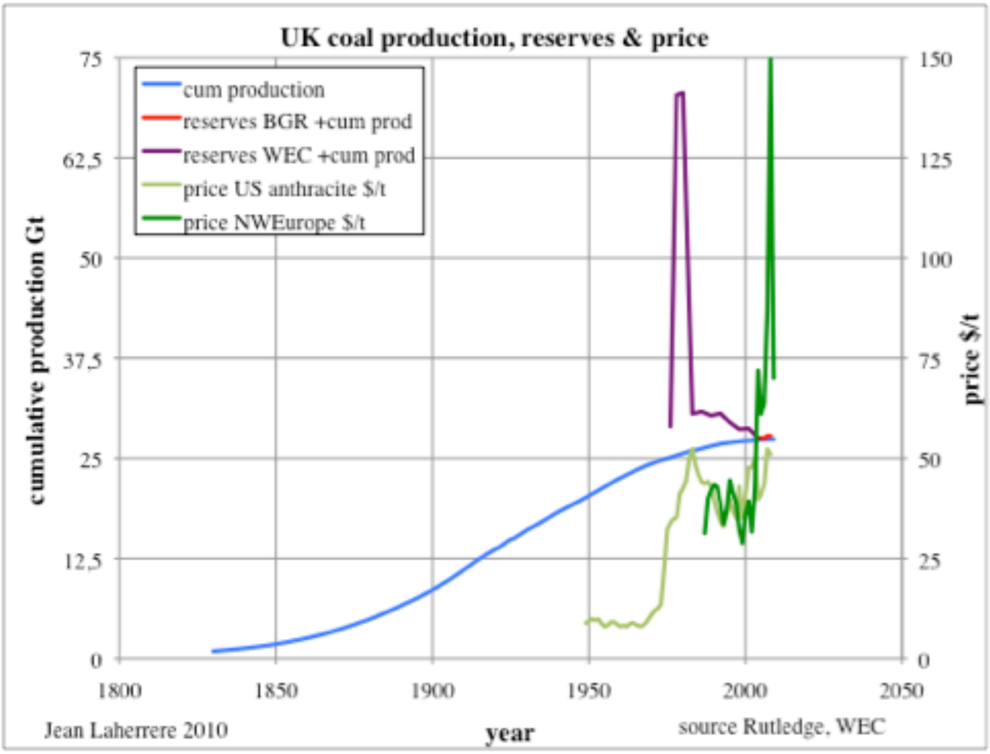
continuous-type accumulations, with HC being continuous in a bad and heterogeneous reservoir.
But unconventional oil & gas production depends upon the price, and estimation of reserves (future production) is difficult to separate from resources (what is in the ground).
Some are reluctant to model unconventional oil & gas, coal and minerals with Hubbert cycles because the ultimates depend on the economic threshold, which depends on price.
But some coal basins are almost depleted and the best examples of Hubbert linearization trend can be found for over 150 years, like UK coal

-UK coal

The linear trend of the period 1850-1900 can be extrapolated to an ultimate of 24 Gt, the period 1850-1950 to an ultimate of 27 Gt and the period 1850-2008 to an ultimate of 28.3 Gt. The sharp rise of coal price in 2008 (but down in 2009) did not change the reserves estimate.
Figure 25: UK coal Hubbert linearization on the period 1830-2008



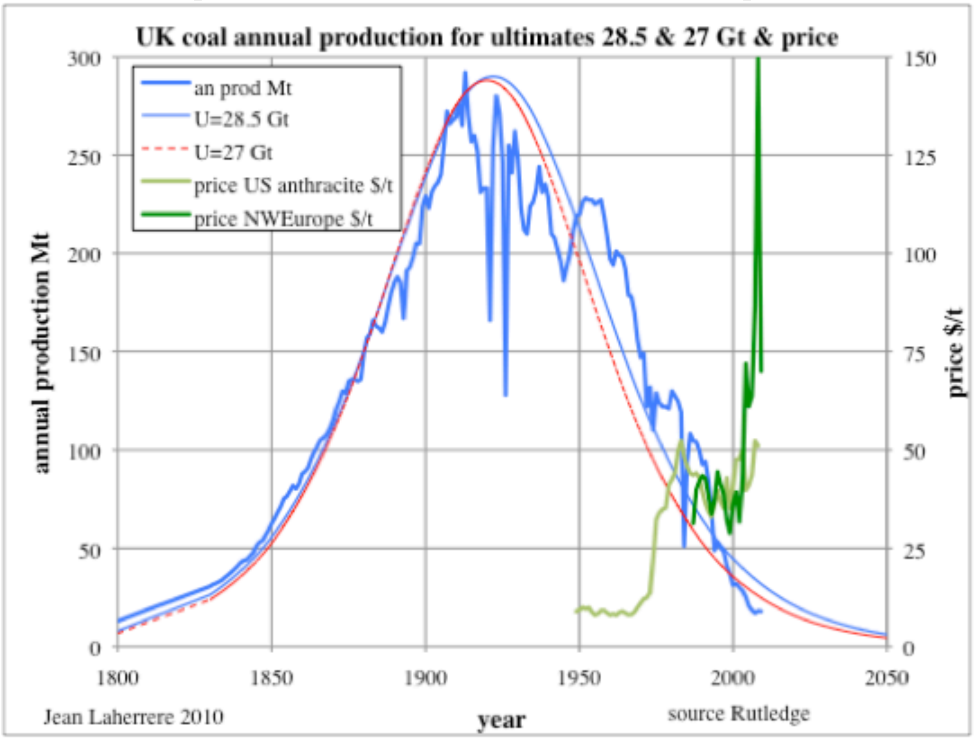
But the reserves estimate by the WEC were less than 4 Gt in 1976, and went up to 45 Gt after the sharp rise in coal price, but in 1983 back to 4.6 Gt despite little change in coal price. Reserves estimate by geologists seems to ignore extrapolations of production trends.
Figure 26: UK coal cumulative production, reserves & price 1830-2008



The UK coal annual production shows a perfect symmetrical pattern when ignoring the disturbances of the two world wars and the recession of 1929. UK coal peak is around 1920

The models with 27 or 28 .5 Gt are very close.

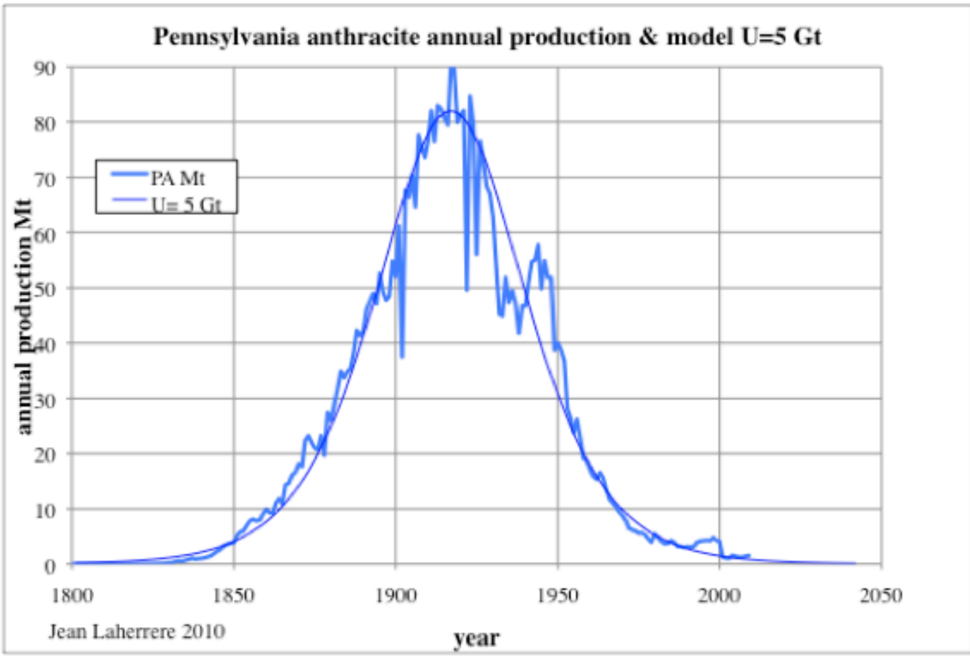
Figure 27: UK coal annual production for ultimates 28.5 & 27 Gt and price



-US Pennsylvania anthracite

Pennsylvania anthracite production displays also a near perfect symmetrical pattern, when ignoring the second war. The production is close to exhaustion, confirming the reality of the ultimate.

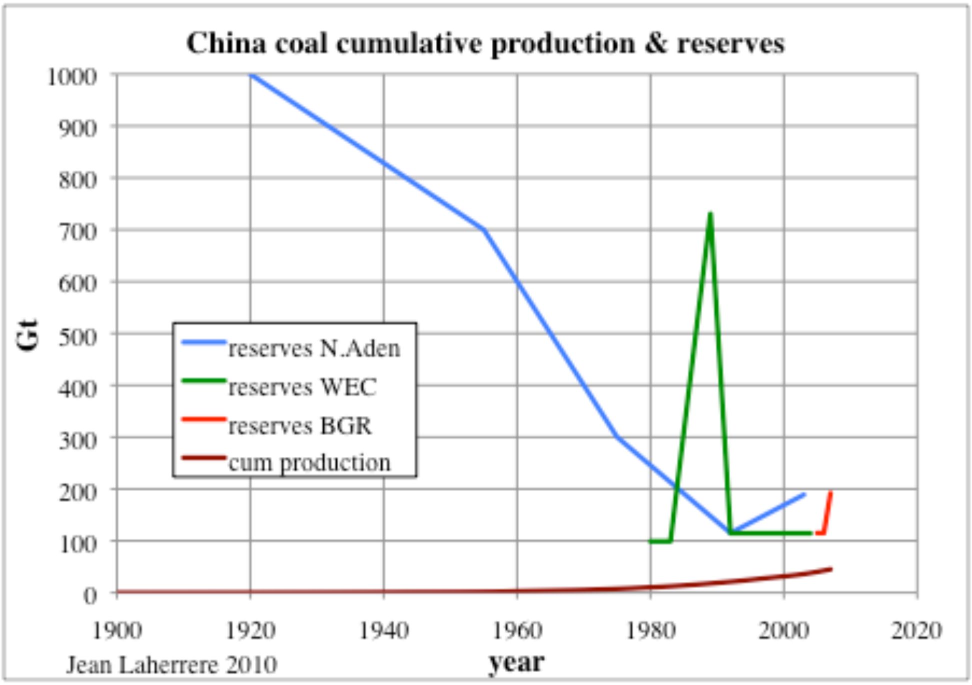
Figure 28: Pennsylvania anthracite production



-China coal

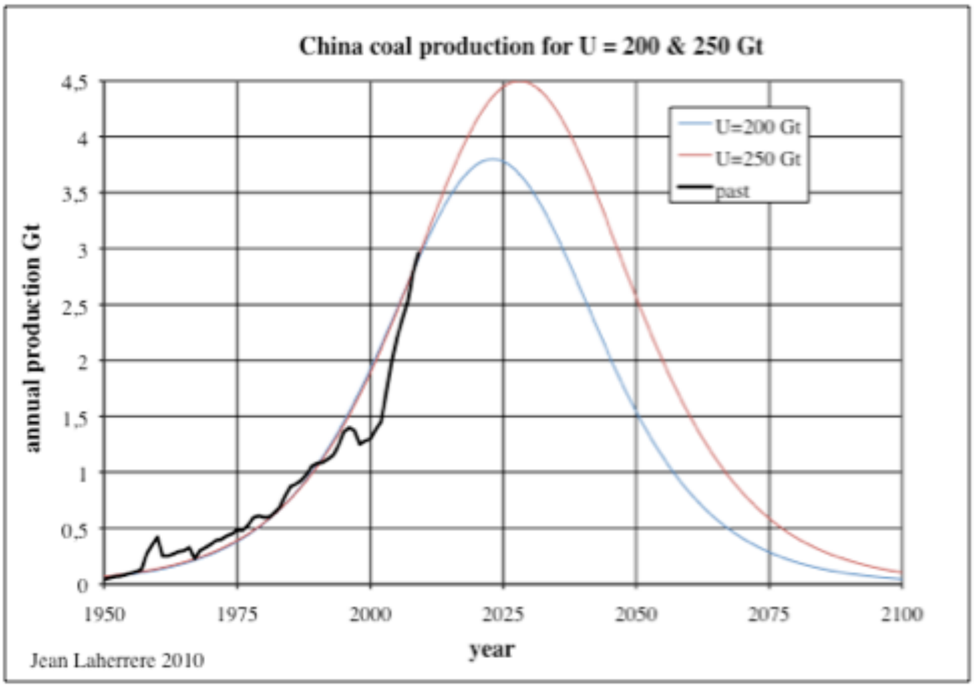
Geological coal reserve estimates in China were very high in 1920 (1000 Gt) but down to 100 Gt in 1992 and lately in 2008 up to about 200 Gt. China increased coal production in the last few years and also starts importing coal, because their huge energy demand to satisfy the needs of the consumption society!

Figure 29: China coal cumulative production & reserves from N.Aden, WEC and BGR



China coal annual production could peak around 2025 for an ultimate varying between 200 and 250 Gt, but this estimate is very unreliable!

Figure 30: China coal annual production for U = 200 & 250 Gt



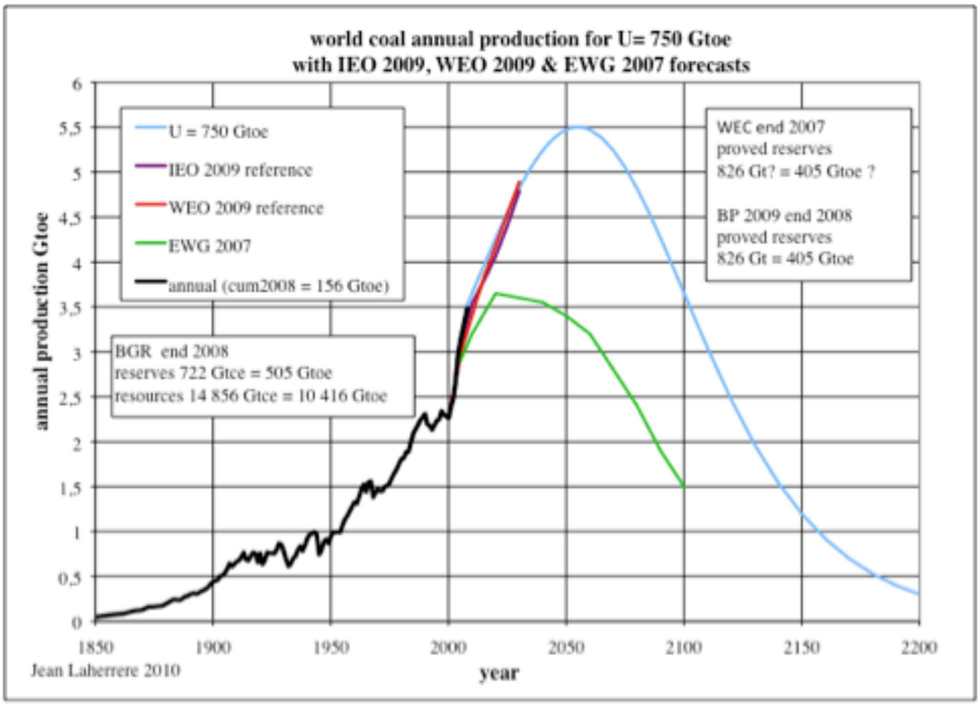
-World coal

The problem for coal is that there is no consensus on a world coal classification because the large range of heat content (from 5 GJ/t in Greece to 32 GJ/t in Venezuela), moisture, and ash from anthracite to lignite. Every country with long historical production wants to keep its own classification. Most countries report production only in tonnes (US in short tons!), many without giving the heat content, and compilation of data is adding apples and oranges. The compilation should be only carried out in tce or toe, but the WEC (which is the best international and democratic association) reports only in tonnes (unwilling to upset its members), only the BGR reports in toe (1 toe can be twice a tonne)!

The uncertainty on the coal ultimate in Gtoe is large, mainly because of China. We assume that it could be 750 Gtoe (our last study was taking 600 Gtoe!)

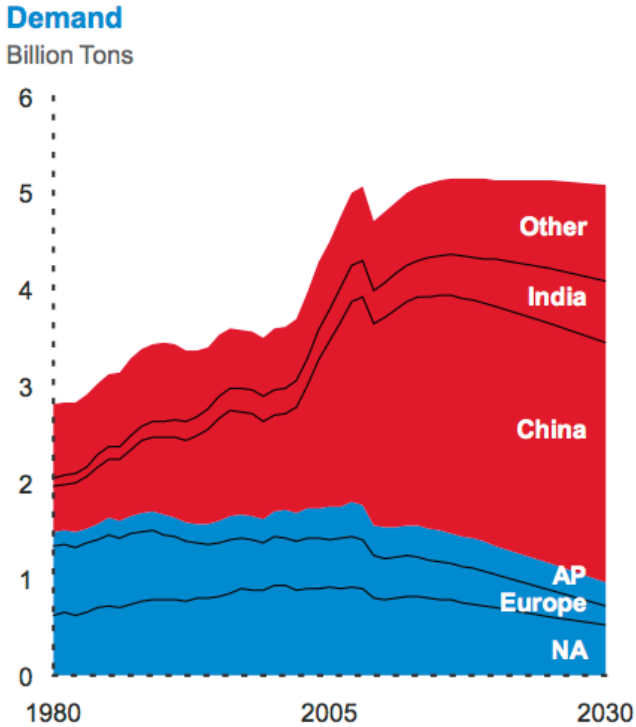
The world coal can peak around 2050 at 5.5 Gtoe. EIA & IEA forecast for 2030 is about 4.8 Gtoe!

Figure 31: world coal annual production for U = 750 Gtoe



The Energy Watch Group forecast in 2007 was lower than EIA & IEA 2009, but Exxon-Mobil 2010 forecasts a flattening of coal demand from now on!

Figure 32: world coal annual demand by Exxon-Mobil (Eizember 2010)

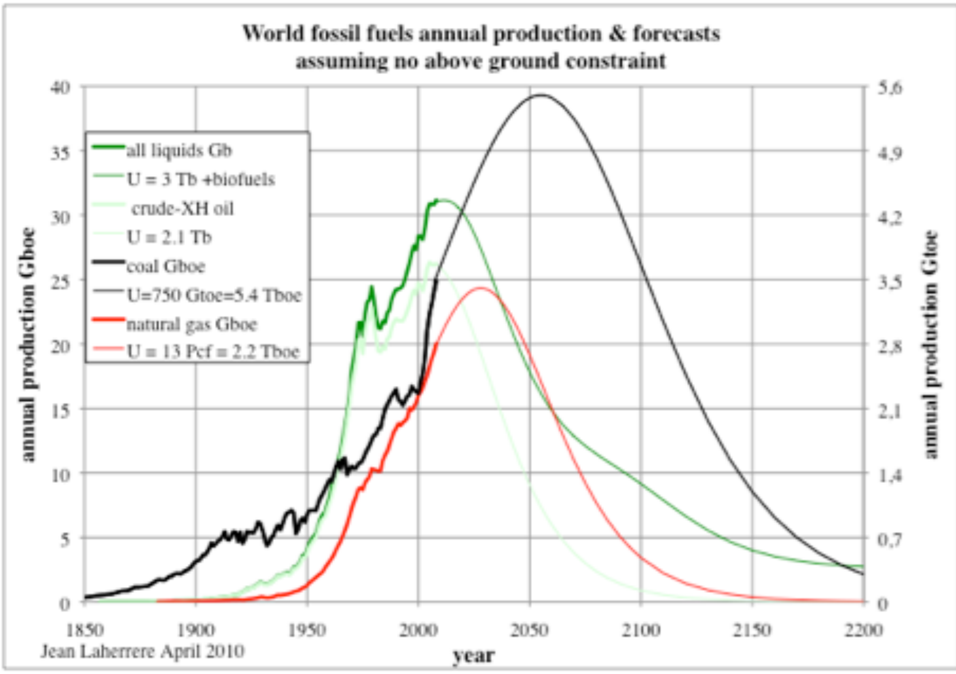


-Fossil fuels

Fossil fuels (assuming ultimates of 750 Gtoe = 5.4 Tboe for coal; 3 Tb + biofuels for all liquids including biofuels; 2.2 Tboe for gas) are modelled assuming no above ground constraint.

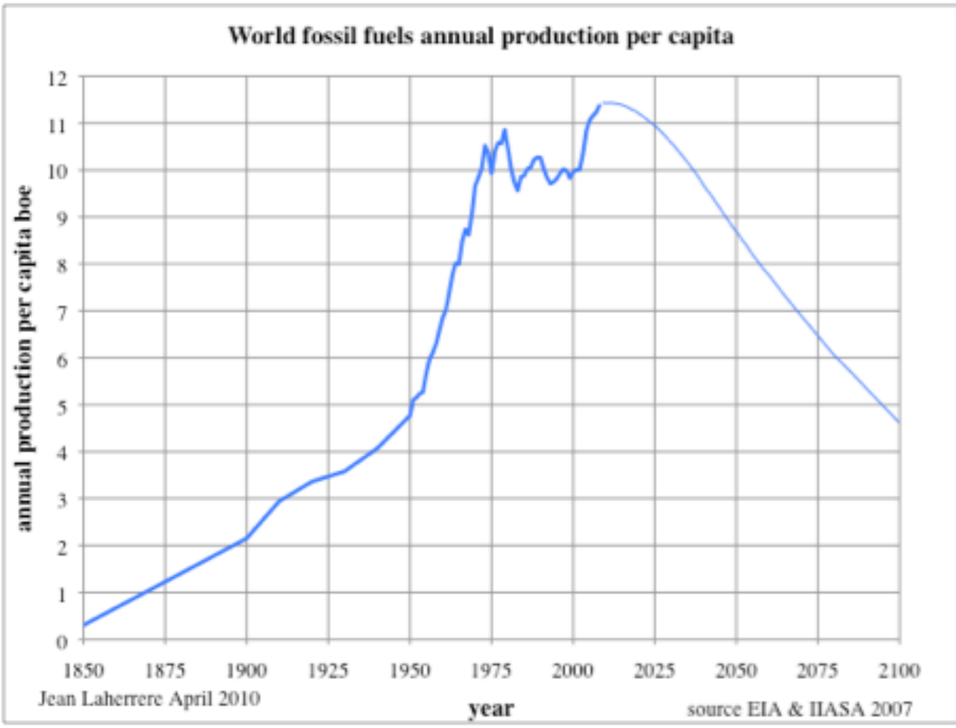
Coal production was first until 1960, taken over by oil, but coal will be back in the driver seat in 2020!

Figure 33: world fossil fuels annual production & forecasts (assuming no above ground constraint)



The annual fossil fuels production by capita is displaying a bumpy plateau from 1973 to 2025, but declining beyond with little hope to be replaced by renewable outside biofuels (biofuels is included in fact in these FF)

Figure 34: world fossil fuels annual production per capita & forecasts (assuming no above ground constraint)



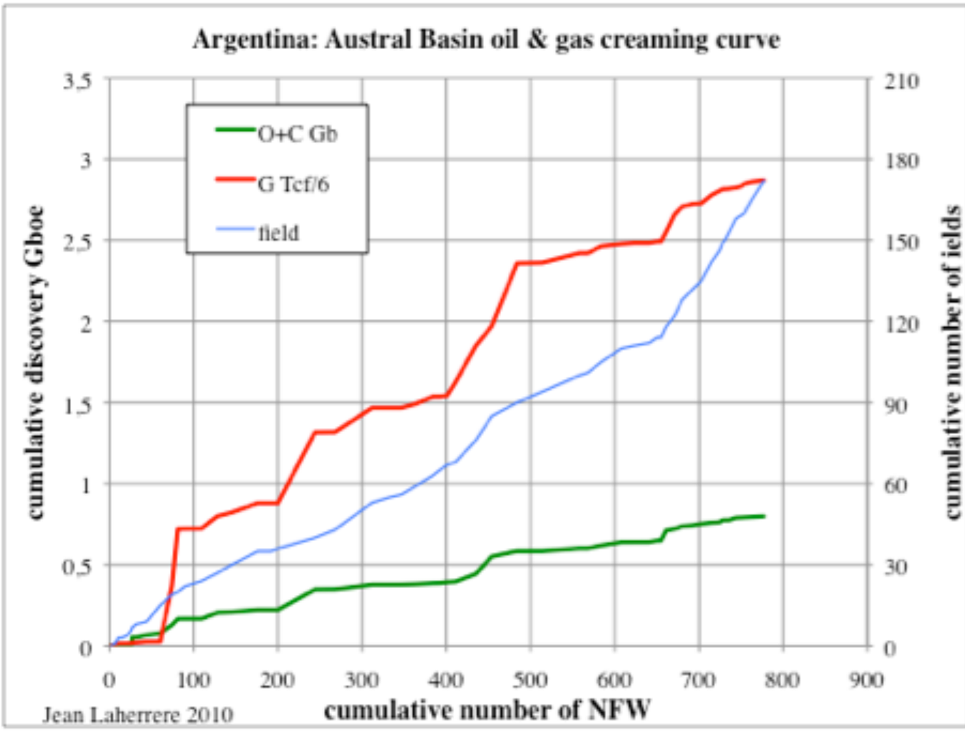
The next ten years can provide the same amount per capita in fossil fuels including biofuels

-Peaks in Argentina

-Oil & gas discovery in Austral Basin & Malvinas

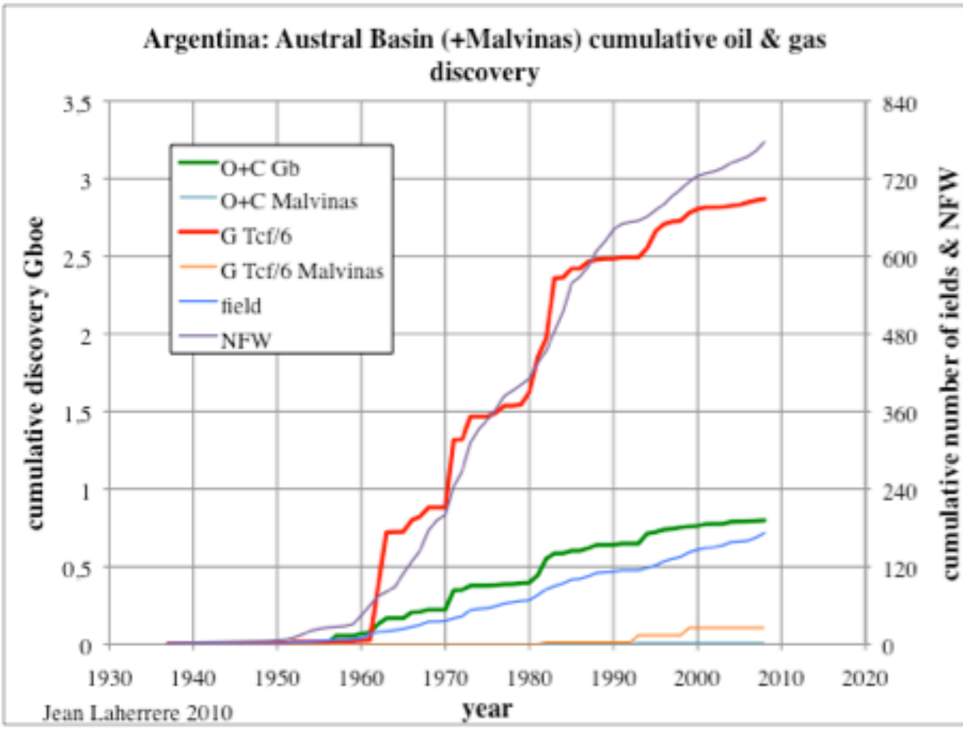
The Austral basin creaming curve shows that this basin is mainly gas-prone, that several cycles have occurred, but both gas and oil cumulative discovery is flattening. The ultimates are likely to be 1 Gb for oil and 3 Gboe = 18 Tcf for gas

Figure 35: Austral Basin oil & gas creaming curve



Since 1995 the number of fields has increased, showing better success ratio, but the cumulative discovery is almost flat for the last 8 years

Figure 36: Austral Basin oil & gas cumulative discovery

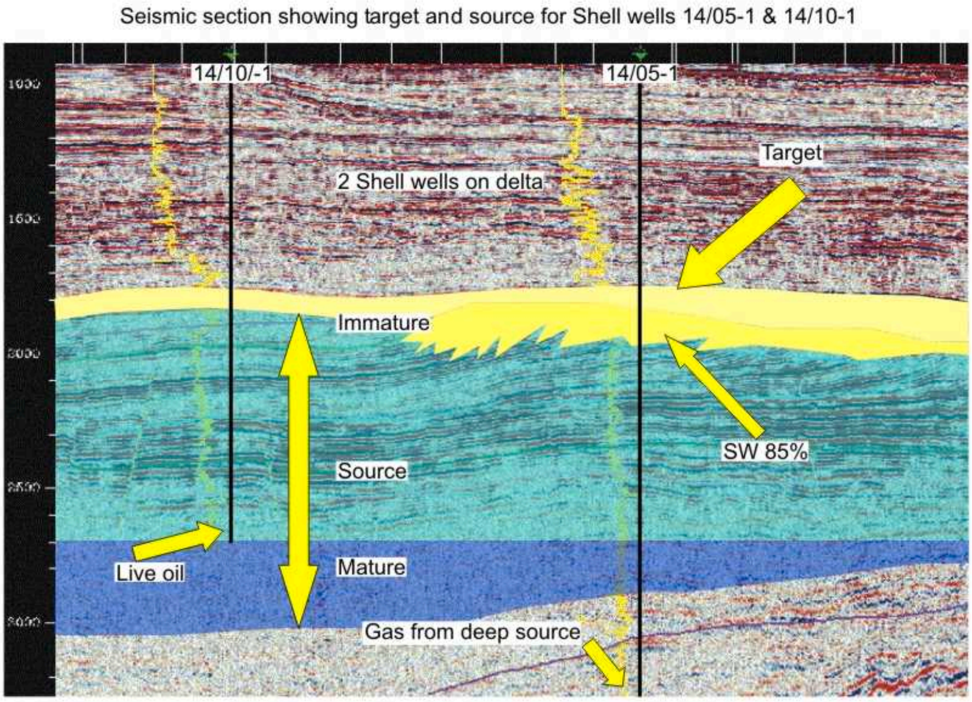


The cumulative discovery in the Malvinas (from 19 NFW) is almost zero for oil and very little for gas. According to Galeazzi (AAPG 1998) those disappointing results are related to insufficient generation; inefficient migration; incomplete preservation of hydrocarbons.

-Oil & gas discovery in Falklands

In 1998 six dry holes were drilled in the North Falkland (west of the Malvinas basin). The dry hole Liz (expected mean reserves 358 Mb with high confidence from Rockhopper) drilled in 2010 was a stratigraphic prospect, showing the lack of good structural leads. The second well Sea Lion (expected mean reserves 170 Mb) just reported an oil discovery is located in close proximity to a 1998 Shell oil show well 14/10-1 (sticking to previous shows). The seismic profile on the two Shell wells is given by the British Geological Survey BGS http://www.bgs.ac.uk/falklands-oil/images/nfb/nfb_shell1b.jpg

Figure 37: Seismic profile on the two Shell wells drilled in 1998

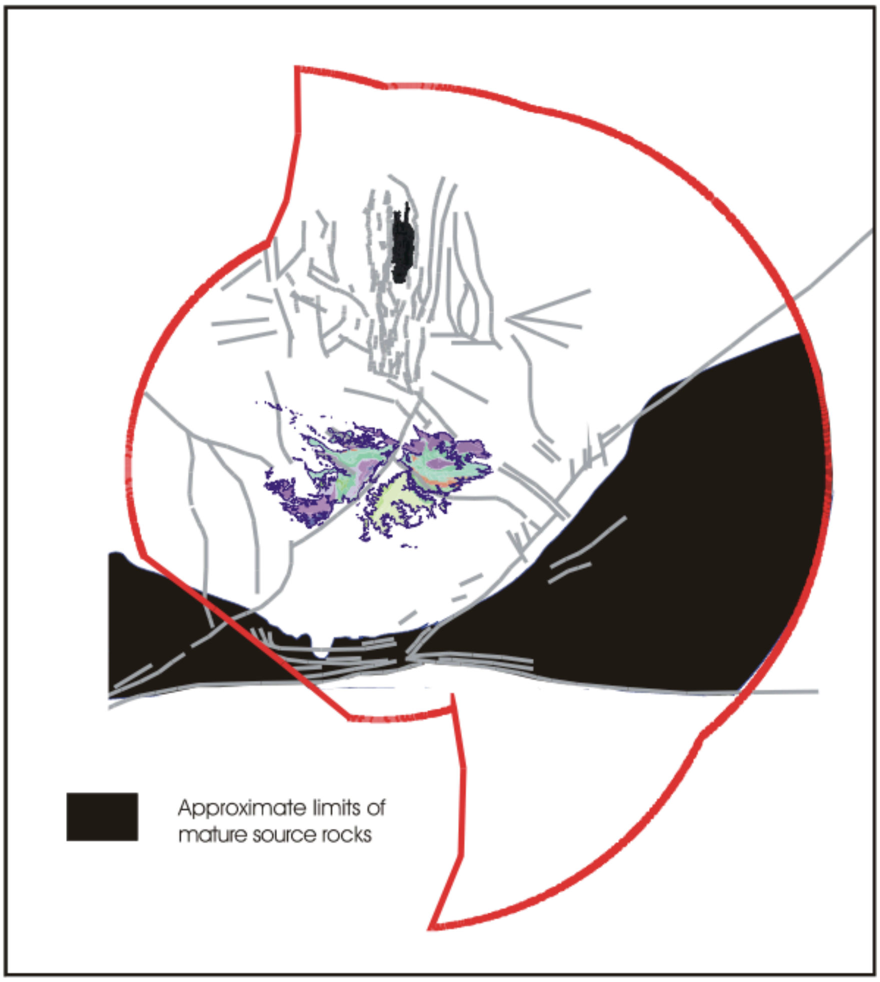


The quality of the seismic is very poor for Shell wells 14/10-1 (oil show) & 14/05-1(gas shows changed into gas discovery in 2009), but good for the two Amerada Hess wells 14/09-1 (dry) & 14/09-2 (oil show).

Electromagnetism data was acquired to remedy to the poor quality of the seismic, but it is not a good substitute!

Phil Richards (BGS) "*Falkland Islands: past exploration strategies and remaining potential in under- explored deepwater basins*" 20th July 2001 http://www.bgs.ac.uk/falklands-oil/download/RichardsGCSSEPMpaper2001.pdf describes the North Falkland as the second richest source rock in the world (100 Gb), but only a very small part of the source-rock is mature (deeper than 3000 m).

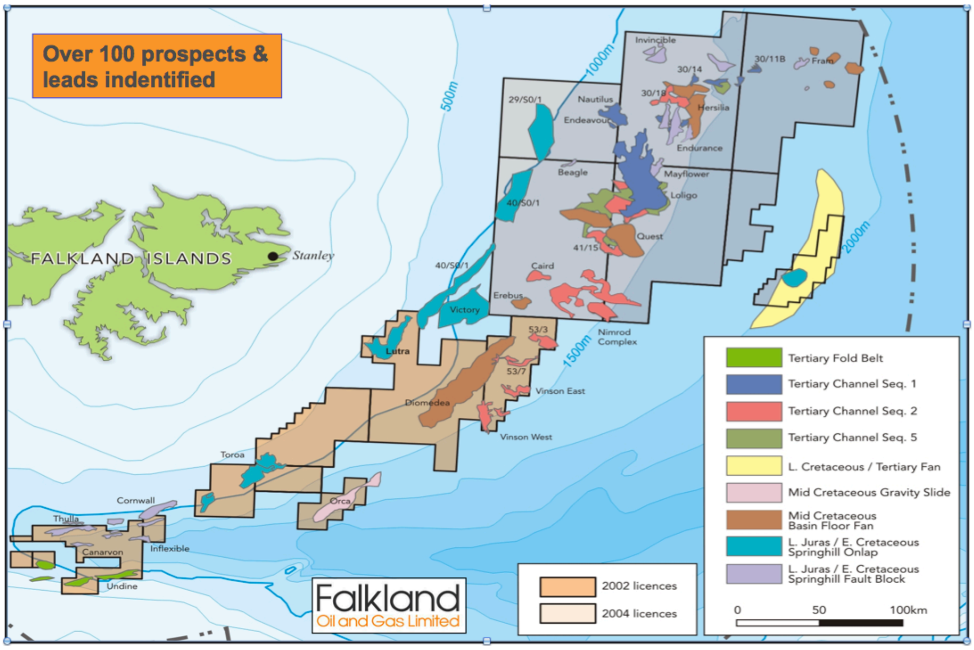
Figure 38: Falkland: Source-rock maturity from BGS



The source-rock maturity looks better in the South & East basin where BHP Billiton (committed to a two wells farm-out from FOGL Falkland Oil and Gas Limited) is planning soon to drill the Toroa prospect (Cretaceous play, 600 m water, 2700 TD, expected reserves 1,7 Gb). But this basin is completely undrilled and risked. The other prospects (as Loligo Tertiary 3 Gb?) need a rig able to drill by 1000 m water depth. These reserves estimates seem much too high when compared to the largest field (112 Mb) of the Austral Basin

FOGL has listed many prospects of several plays http://www.fox-davies.com/media/122053/falklandreportfeb12010webversion.pdf

Figure 39: Prospects in South & East Falkland on FOGL leases

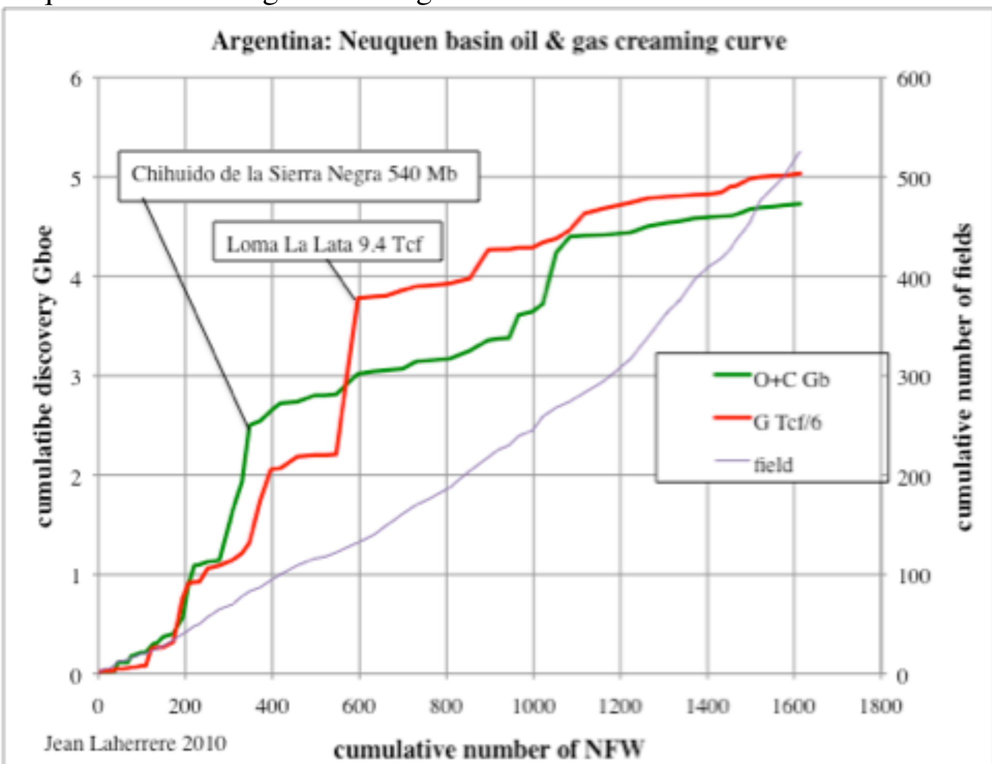


The present drilling program from small UK companies (with attractive names like Desire or Rockhopper) seems to aim more the stock market than future development. It is necessary to wait to end 2010 for the two BHP wells to have a good assessment of the Falkland potential. But I doubt that any Falkland oil discovery would be economical!

-Oil & gas discovery in Neuquen

The Neuquen basin holds more reserves. The ultimates are likely to be 5 Gb and over 30 Tcf

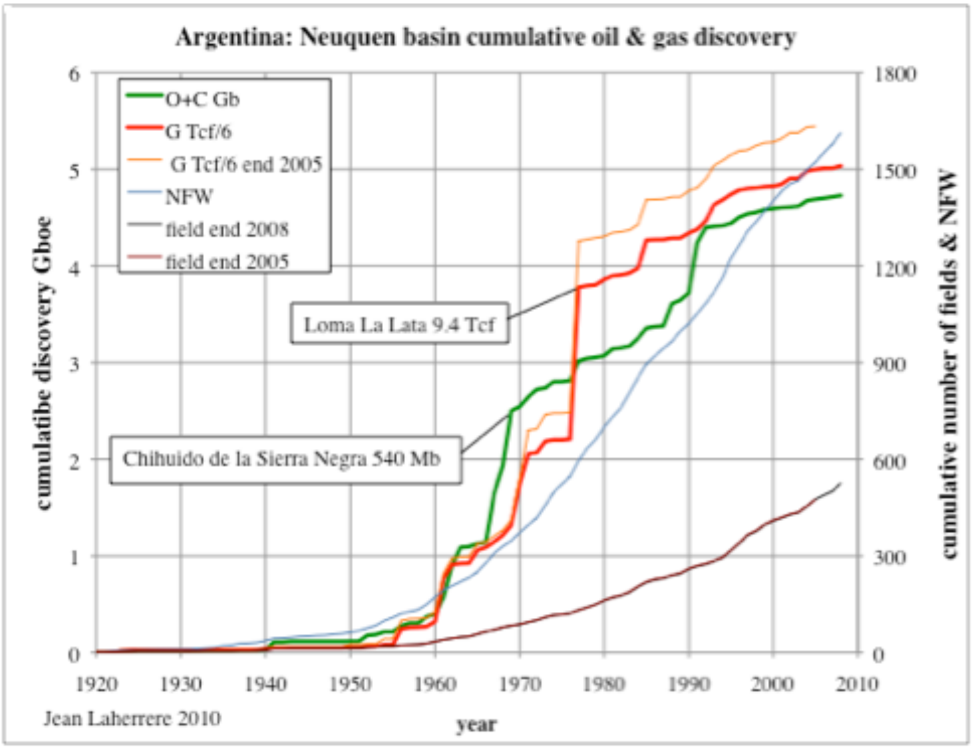
Figure 40: Neuquen Basin oil & gas creaming curve



The Neuquen Basin is almost thoroughly explored with the cumulative oil and gas flattening when the number of fields has increased since 1995.

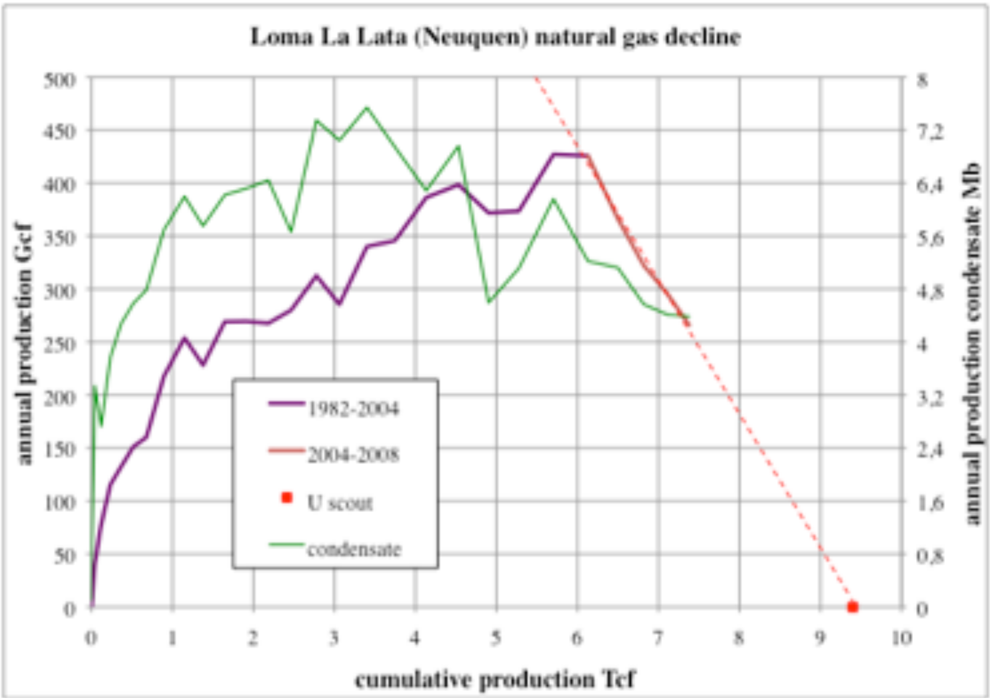
The creaming curve has steps with the discovery of the two large fields: Loma de la Lata gasfield and Chihuido de la Sierra Negra oilfield

Figure 41: Neuquen Basin oil & gas cumulative discovery



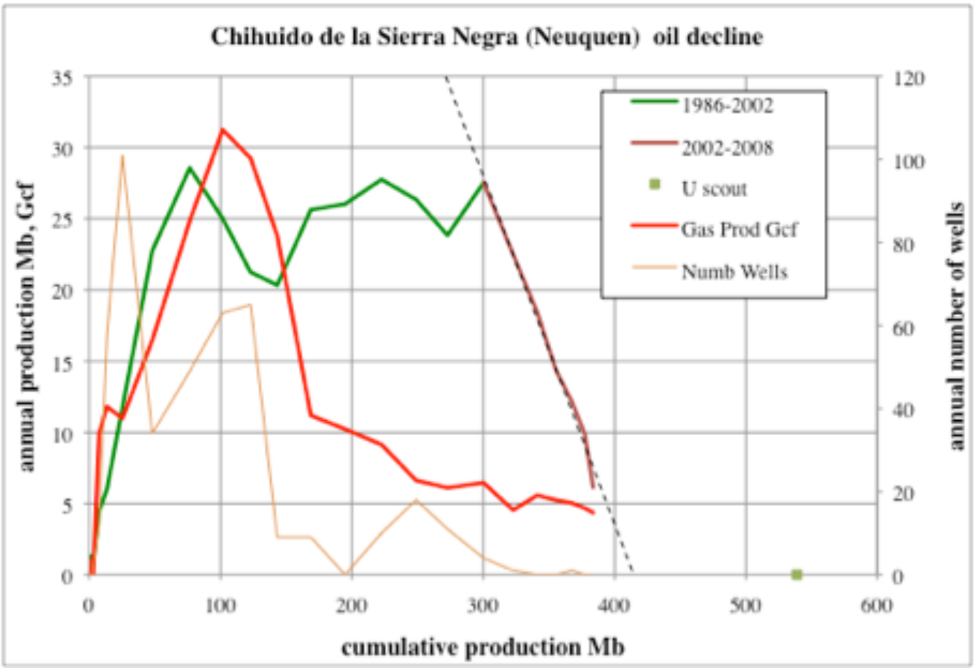
The largest Argentina gasfield Loma de la Lata is declining since 2004 and the ultimate seems to be 9,4 Tcf, as reported by the scout database.

Figure 42: Loma de la Lata gas decline



The largest Argentina oilfield Chihuido de la Sierra Negra production declines since 2002 towards an ultimate of 420 Mb much less than the 540 Mb reported by the scout database.

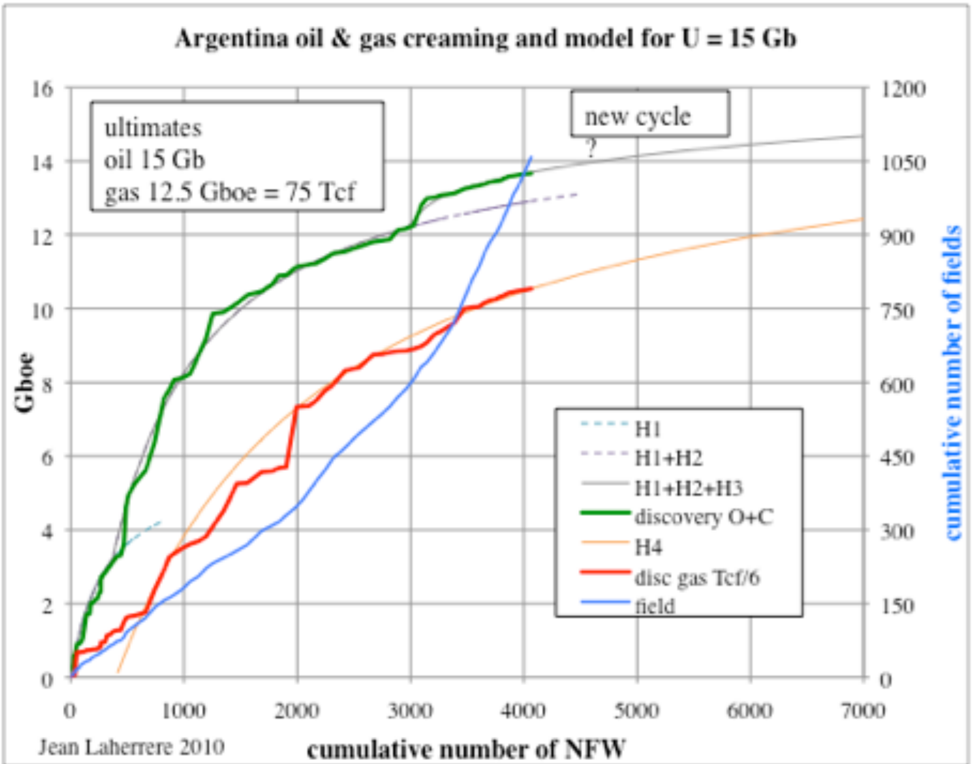
Figure 43: Chihuido de la Sierra Negra oil decline



-Argentina oil & gas discovery and production

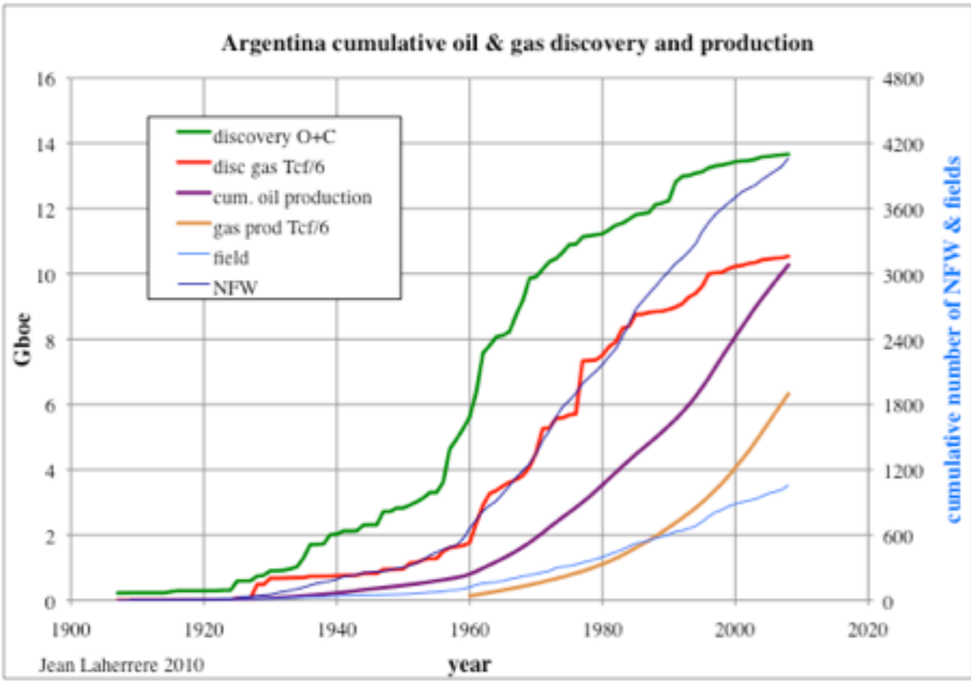
The Argentina creaming curve for oil displays three cycles trending towards an ultimate of 15 Gb, assuming no new cycle (deepwater?). The gas creaming curve trends towards an ultimate of 75 Tcf. Since 1995 the number of fields has increased more than before, but the volume is decreasing.

Figure 44: Argentina oil & gas creaming curve and model for ultimates of 15 Gb & 75 Tcf

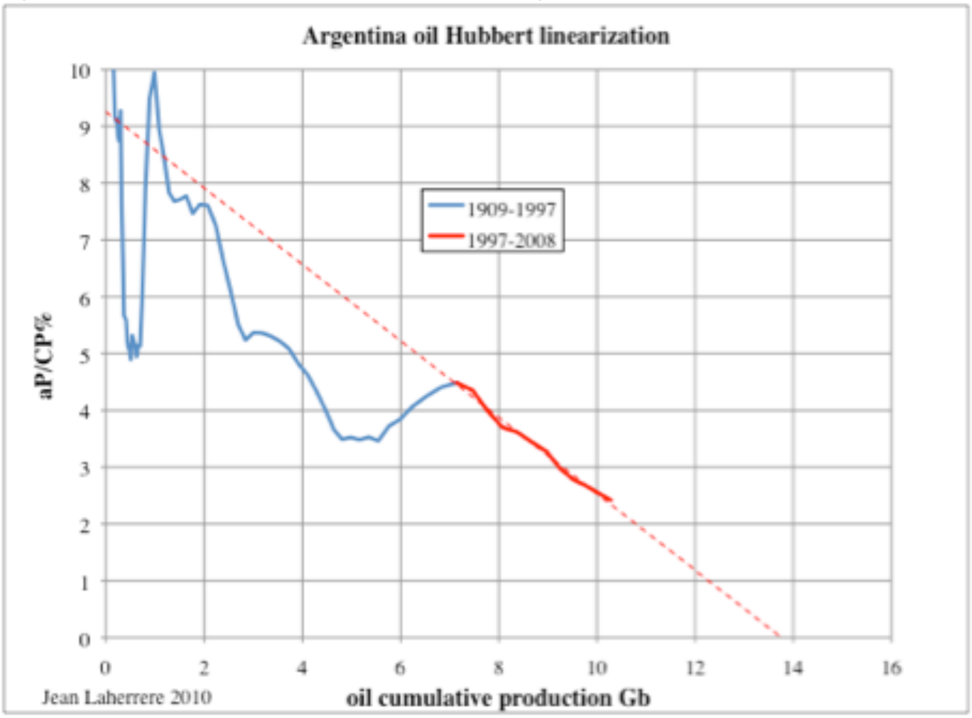


The cumulative discovery is plotted with the cumulative production versus time.

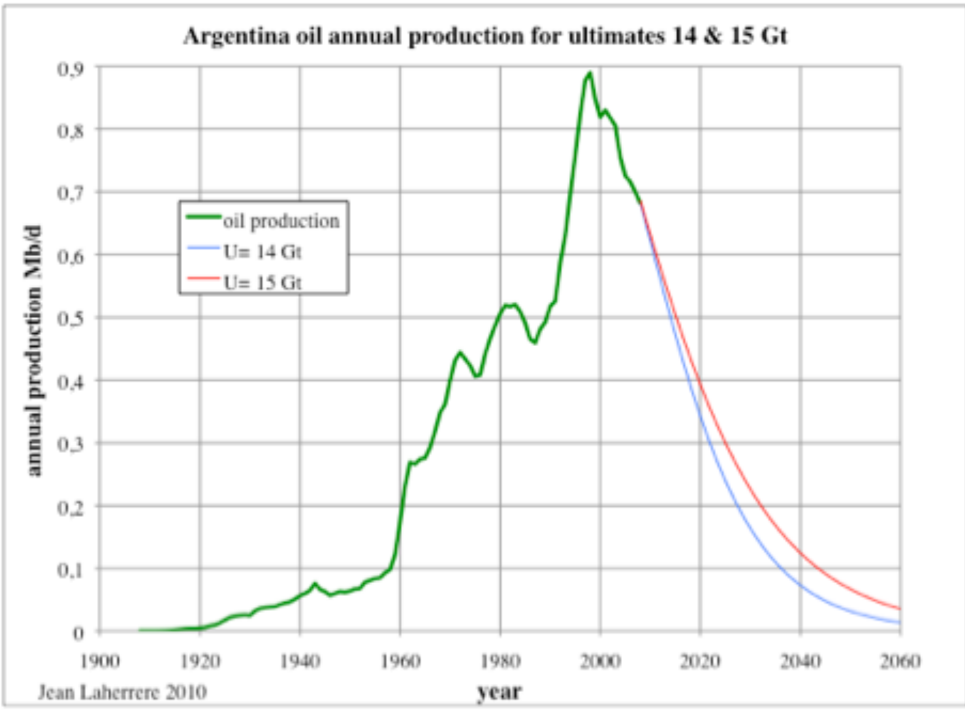
Figure 45: Argentina oil & gas cumulative discovery and production



Argentina oil Hubbert linearization is crooked but the last period 1997-2008 trends towards 14 Gb.
Figure 46: Argentina oil Hubbert linearization trending towards 14 Gb

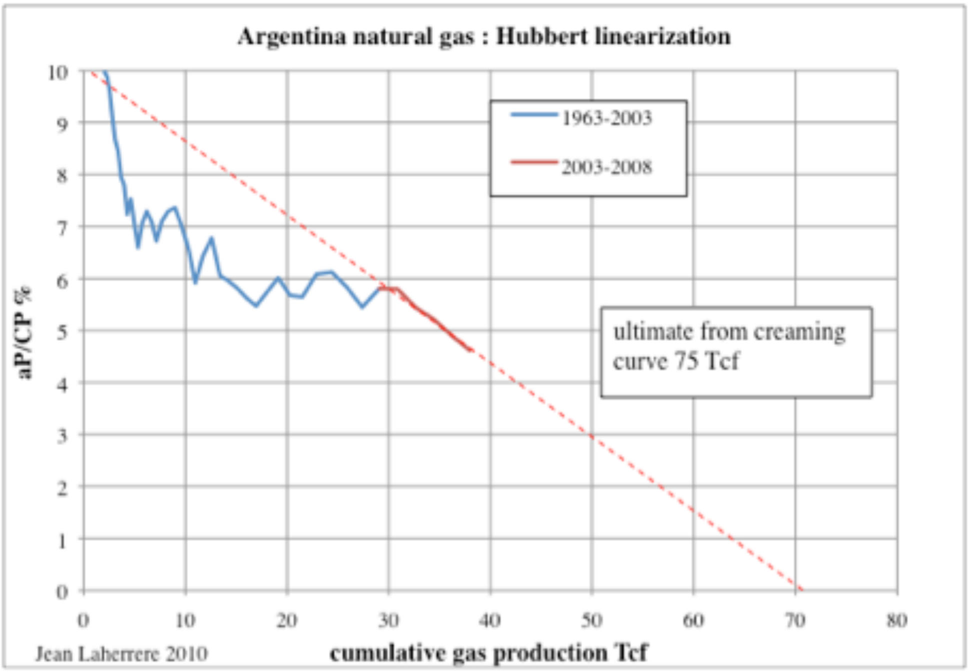


The annual oil production is modelled with the two ultimates: 14 Gb (extrapolation of production) and 15 Gb (extrapolation of discovery), but in fact the difference is small. The present oil production decline will continue in the future on the same slope.
Figure 47: Argentina oil annual production for an ultimate of 14 & 15 Gb



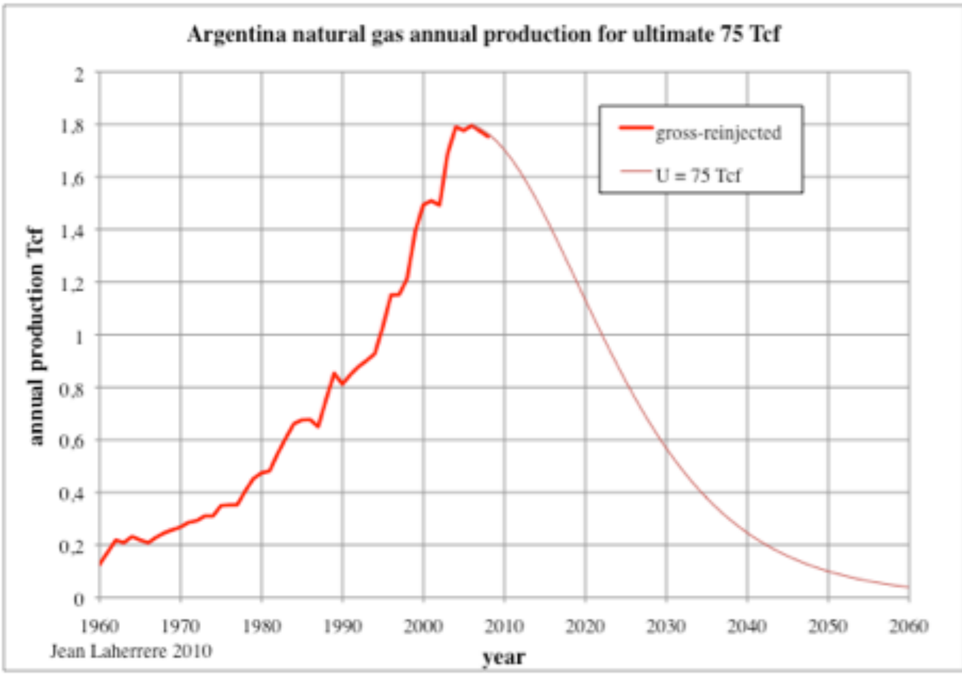
The gas production Hubbert linearization is also crooked, but the last period 2003-2008 trends towards 70 Tcf, yet it is not really reliable!

Figure 48: Argentina natural gas Hubbert linearization trending towards 70 Tcf



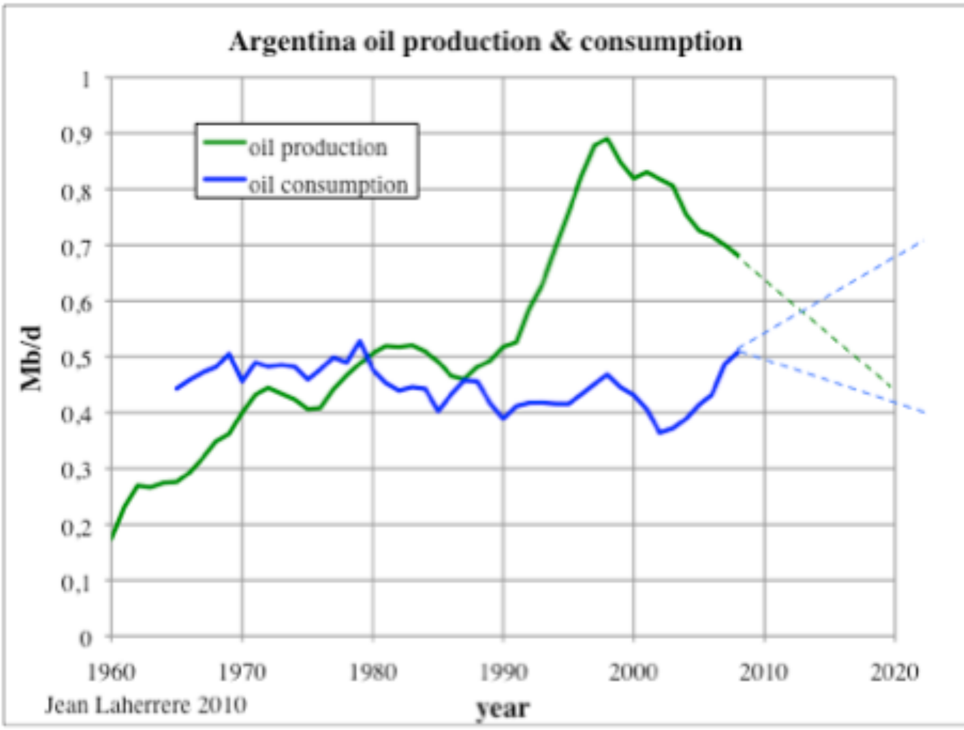
I rely more on the creaming curve and the annual gas production is modelled with an ultimate of 75 Tcf, confirming that the gas peak of 2006, at 1.8 Tcf, is likely to stand.

Figure 49: Argentina natural gas annual production for ultimate 75 Tcf



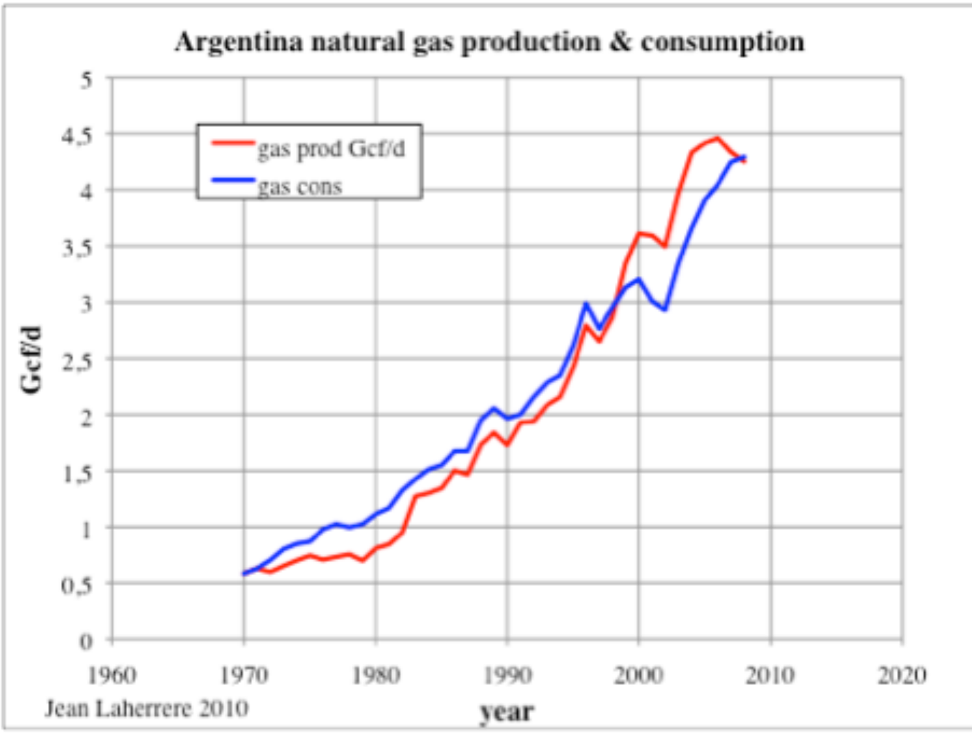
The Argentina oil production is compared with oil consumption. Oil production is declining and will continue, when oil consumption is on the increase since 2002. It is likely that in few years Argentina will be obliged to import oil!

Figure 50: Argentina oil production and consumption

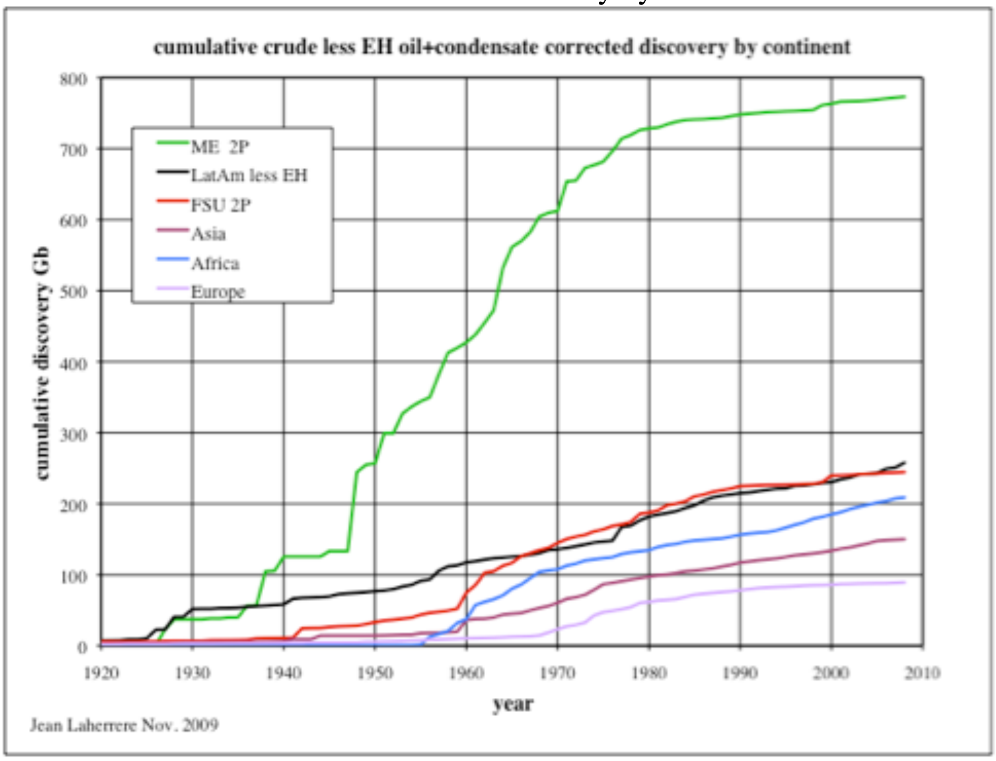


Argentina gas consumption has increased with gas production but since 2008 Argentina has had to import gas.

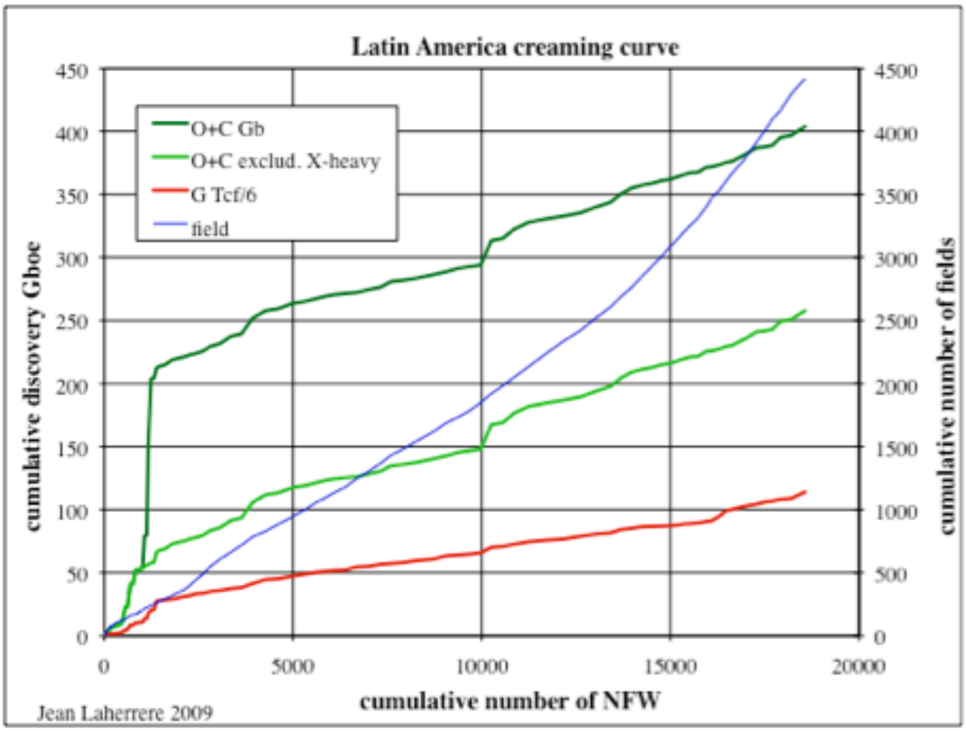
Figure 51: Argentina natural gas production and consumption



-Oil peak in Latin America
Latin America is the second largest crude less XH oil cumulative discovery after the Middle East, very close to FSU.
Figure 52: cumulative crude less XH oil corrected discovery by continent

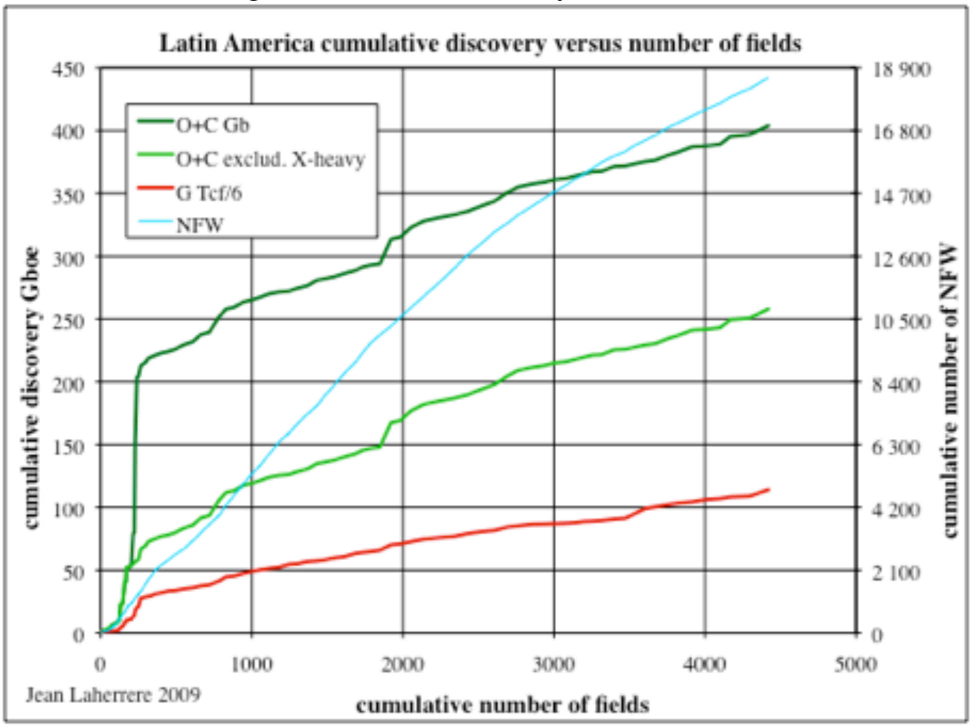


Latin America crude less XH oil creaming curve does not show any sign of flattening thanks to Brazil discovery
Figure 53: Latin America oil & gas creaming curve



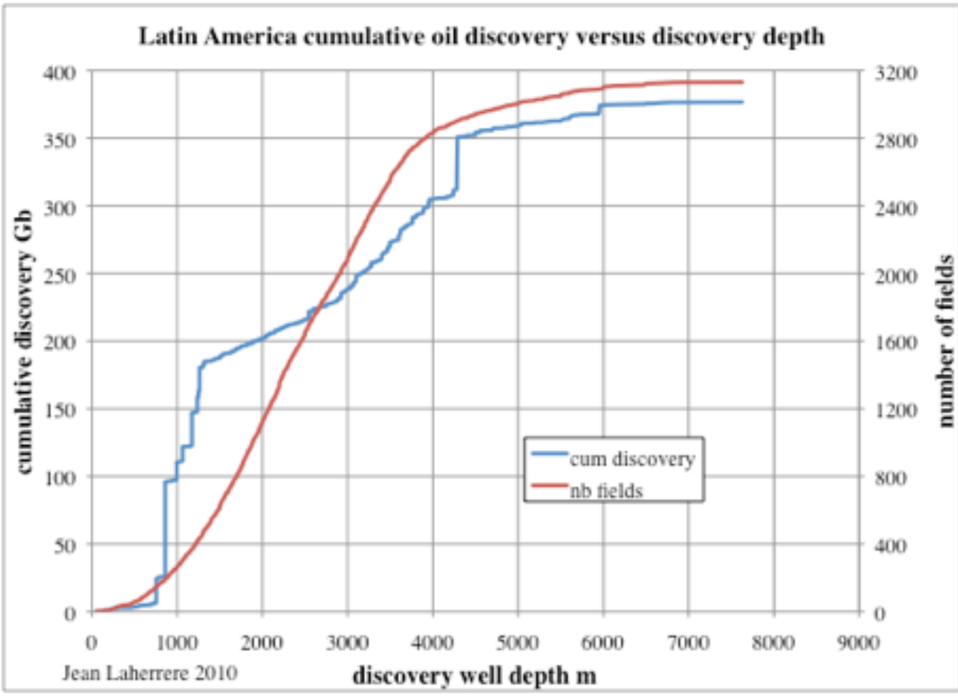
The cumulative discovery versus cumulative number of fields (substitute for the creaming curve when NFW data is not available) shows simiular trends.

Figure 54: Latin America oil & gas cumulative discovery versus cumulative number of fields



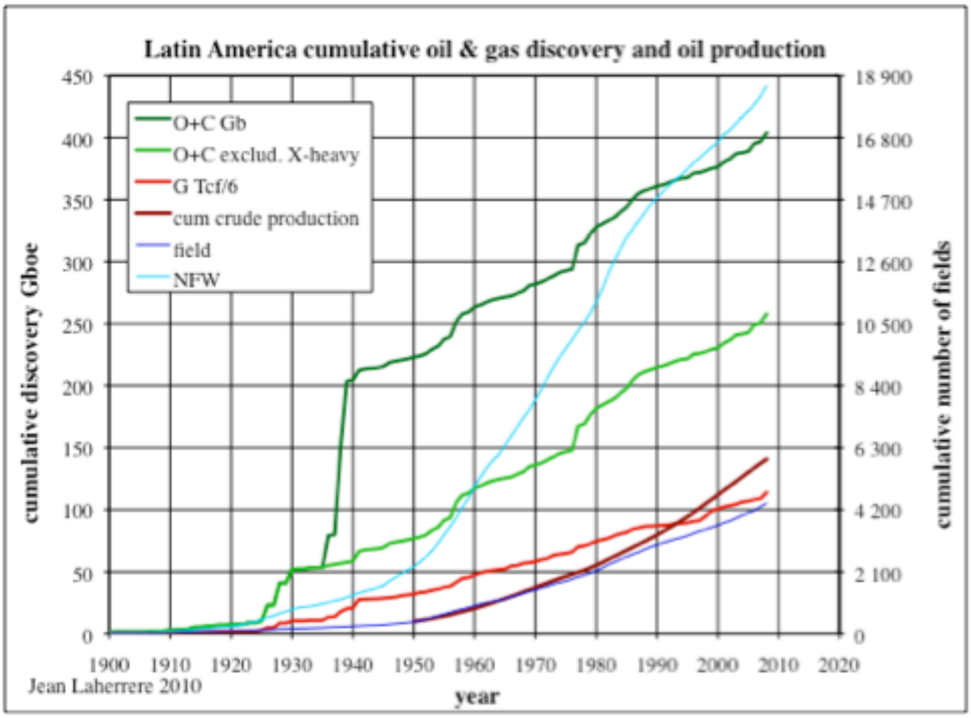
The question of a possible new cycle occurs mainly for deepwater and deep reservoir potential. The cumulative oil (including XH) discovery versus depth of the discovery well shows that very little is found deeper than 6000 m and that the potential for deep reservoirs looks poor.

Figure 55: Latin America oil cumulative discovery versus discovery depth



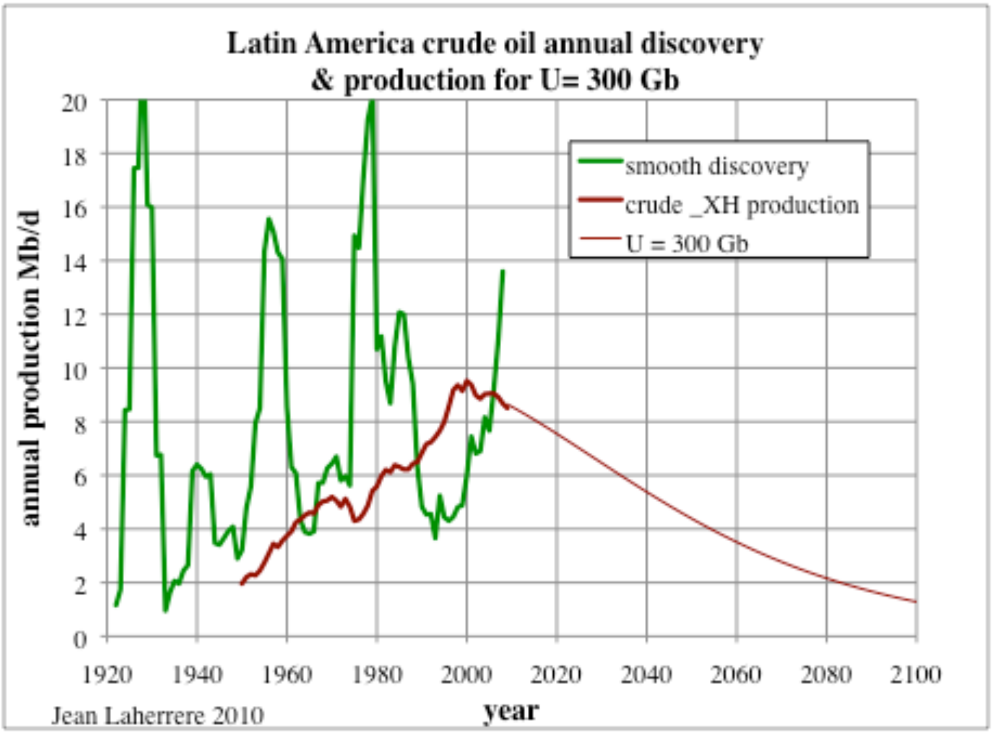
The cumulative oil & gas discovery is compared to oil cumulative production

Figure 56: Latin America oil & gas cumulative discovery and oil production



The annual crude –XH oil discovery & production is modelled for an ultimate of 300 Gb. Oil production has peaked in 2000.

Figure 57: Latin America crude less XH oil annual discovery & production

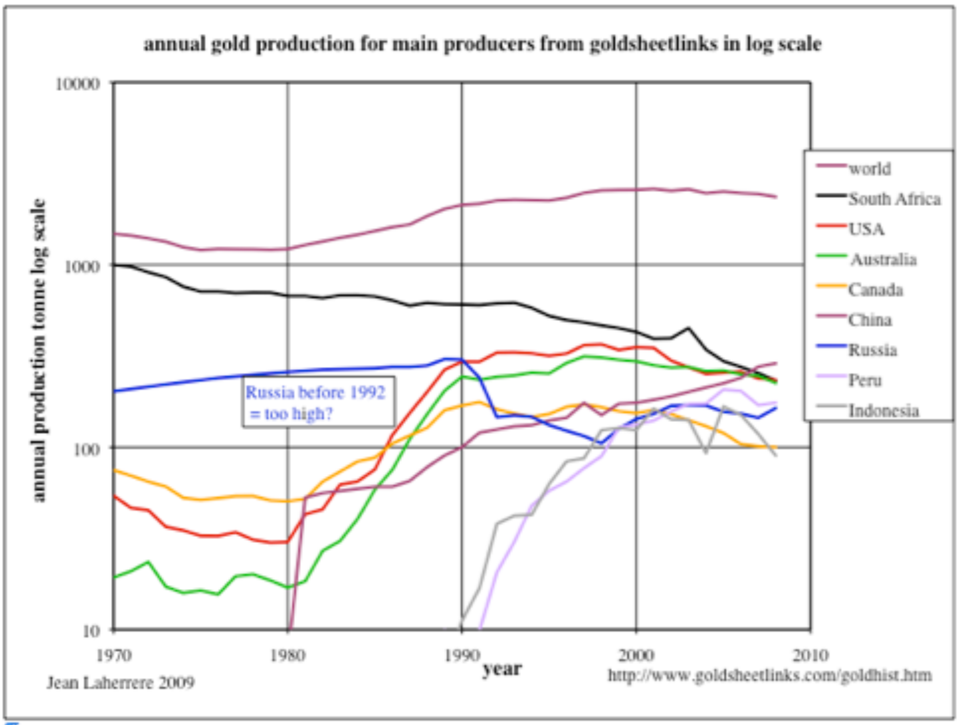


-Minerals peak
Minerals also display peaking for many of them.

-Gold peak

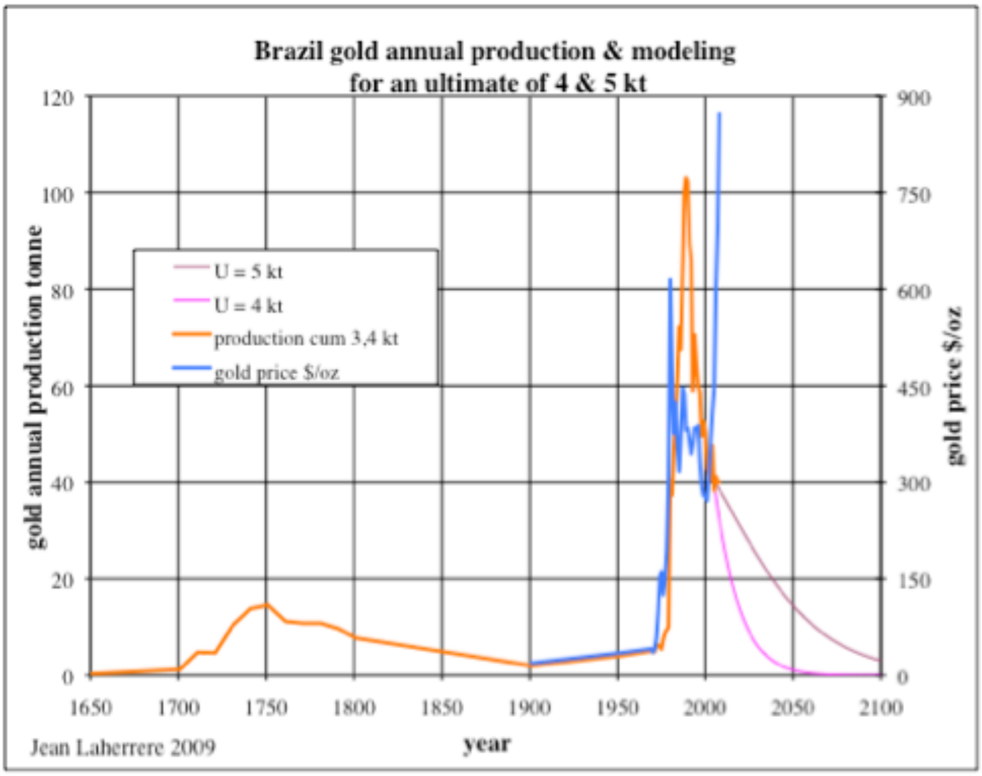
There were many gold producers for millennia, but it is hard to find reliable historical data, mainly for FSU during the cold war. South Africa has been for long the first producer, but it lost the first rank to China.

Figure 58: gold annual production for the world & main producers in log scale

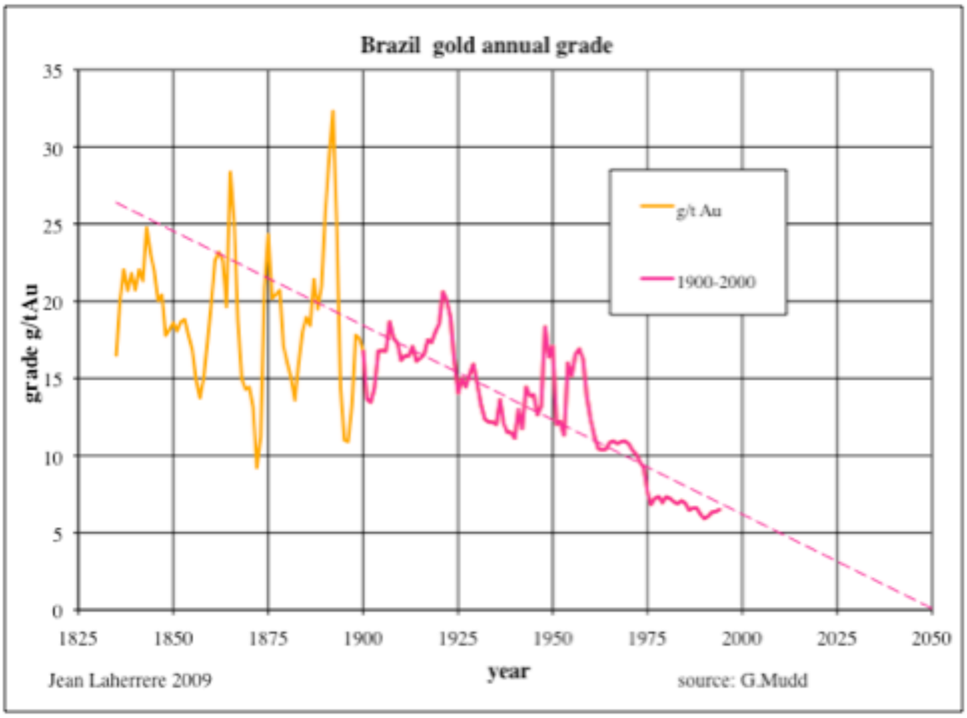


-Brazil gold

The Brazil Gold Rush started in the 1690s, when Bandeirantes discovered large gold deposits in the mountains of Minas Gerais.
Brazil's cumulative gold production is 3.4 kt in 2008 and can be modelled for an ultimate of 4 kt & 5 kt (USGS reserves = 2 kt and reserve base = 2.5 kt)
Brazil's gold production has peaked in 1990 and will decline to almost zero around 2050 or 2100 depending on the ultimate.
Figure 59: Brazil annual gold production and modelling for an ultimate of 4 kt & 5 kt



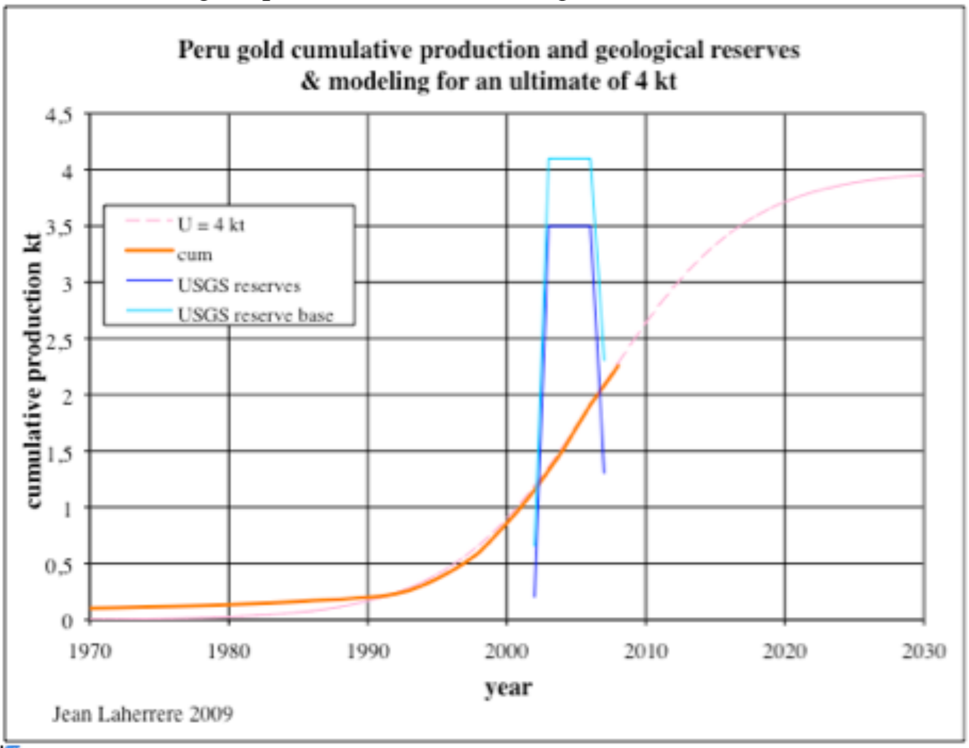
Brazil's gold grade has been declining since 1900 and can be extrapolated towards zero around 2050, which leads to consider the USGS reserve estimate too high and only the 4 kt ultimate being likely.
Figure 60: Brazil gold grade



-Peru gold

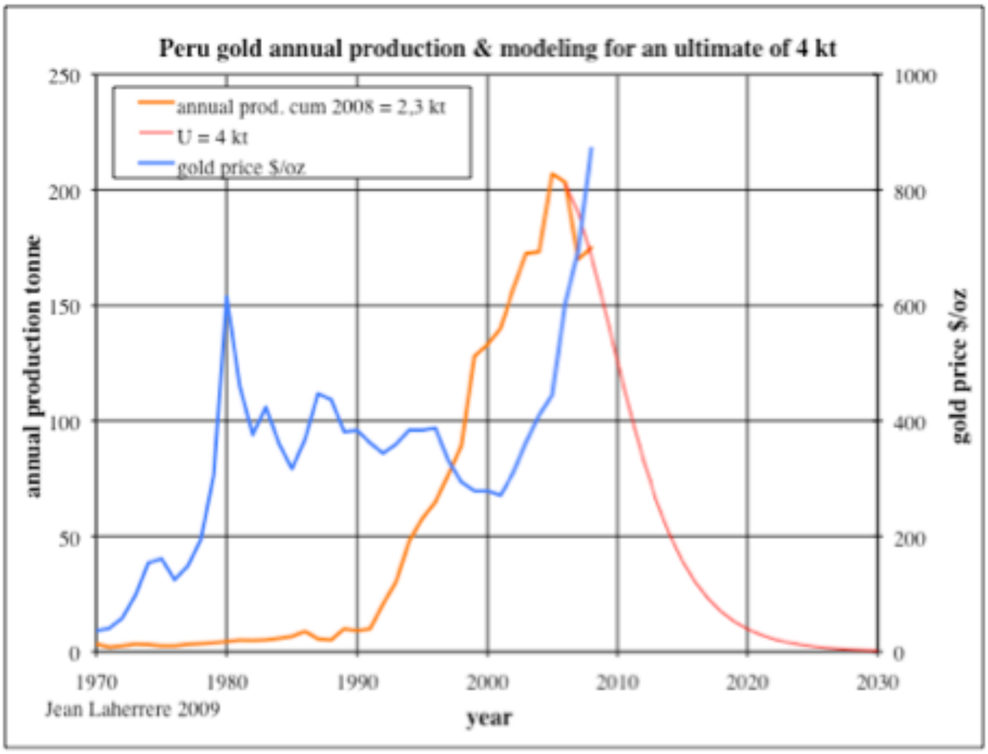
Gold was produced long before the Spanish conquest, but data starts in 1491. Cumulative gold production is 2.3 kt in 2008 and modelled for an ultimate of 4 kt. USGS estimates for reserves were high in 2004, but dropped to 1.2 kt with a reserve base at 2.3 kt.

Figure 61: Peru cumulative gold production & modelling for an ultimate of 4 kt



Peru's gold production has peaked in 2005 and will decline until exhaustion around 2025.

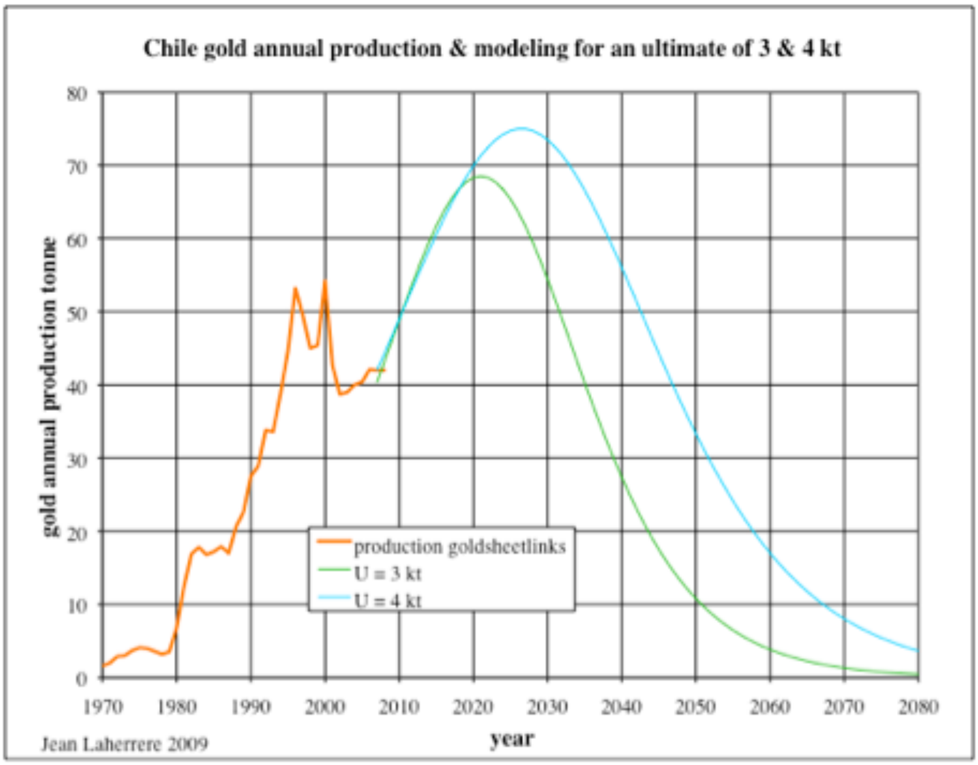
Figure 62: Peru annual gold production & modelling for an ultimate of 4 kt



-Chile gold

Chile gold production has peaked at the end of the 1990s, but it will peak again in the 2020s for a higher peak.

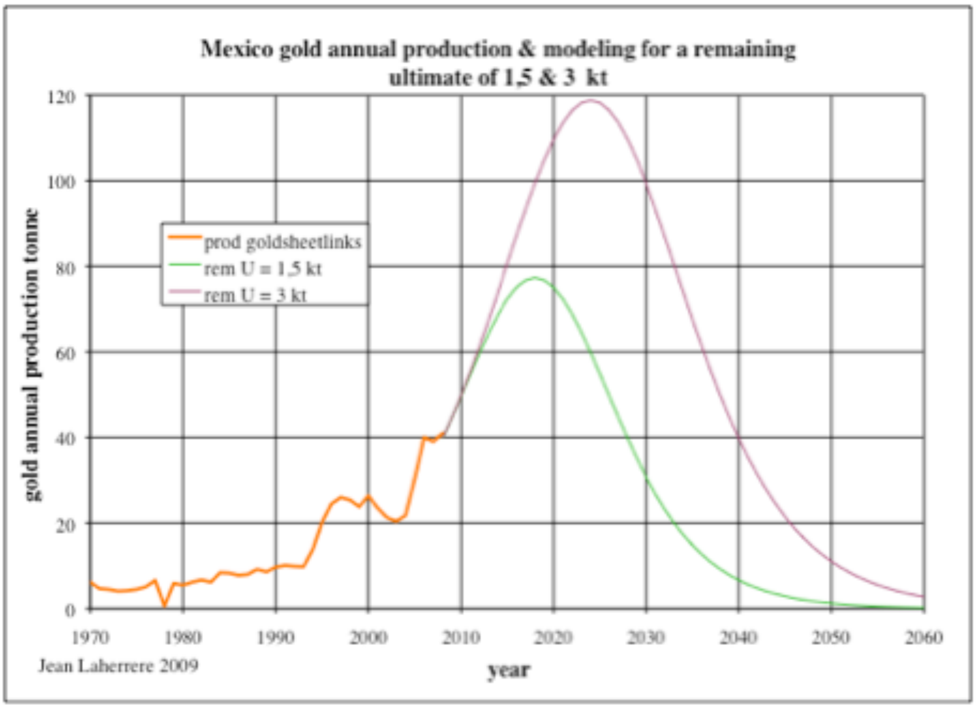
Figure 63: Chile annual gold production & modelling for an ultimate of 3 & 4 kt



-Mexico gold

Mexico gold production will peak in the 20s but the historical data and reserves seem unreliable

Figure 64: Mexico annual gold production & modelling for a remaining ultimate of 1.5 & 3 kt

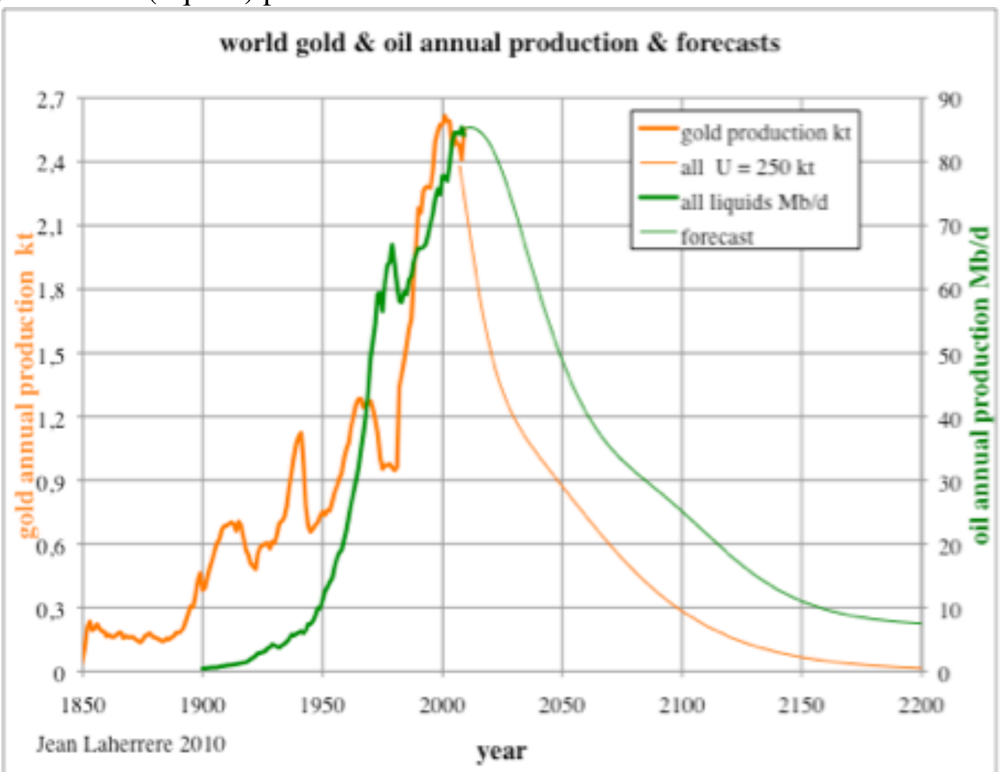


-World gold

The display of gold production & forecast for an ultimate of 250 kt is compared to oil (liquids) production.

It is amazing to find that gold and oil = black gold are peaking in our present decade, and their decline look parallel, in contrary to their rise where gold started millennia before!

Figure 65: gold and oil (liquids) production & forecasts 1800-2200

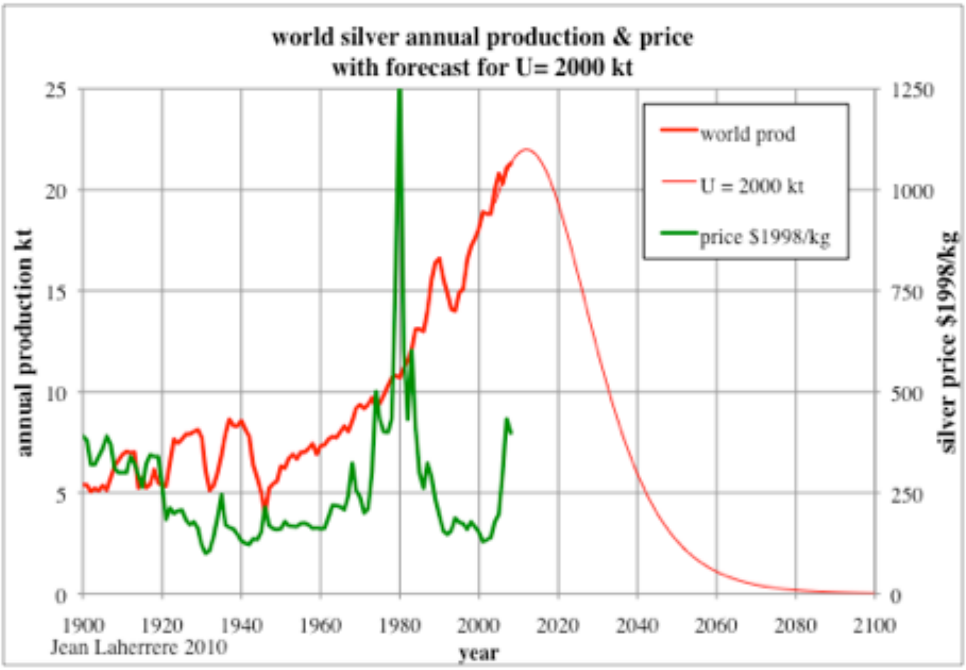


-Silver peak

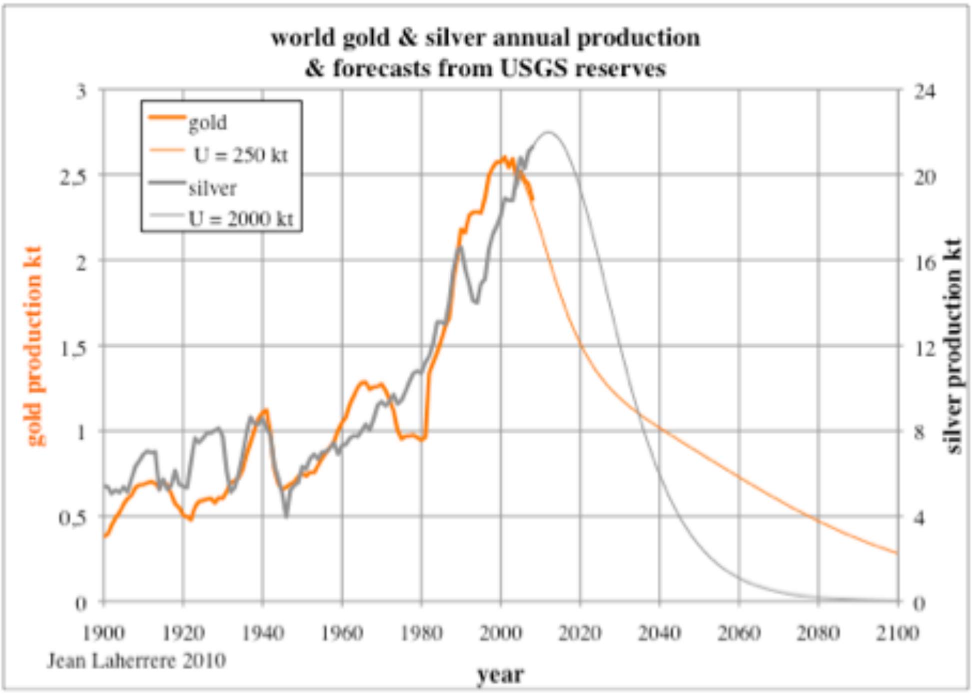
Argentina was wrongly called the country of silver, like North American aborigines called Indians!

Argentina = argentum = silver = rio de la plata

The largest silver producer is Peru.
Figure 66: world silver annual production & forecast U=2 Mt



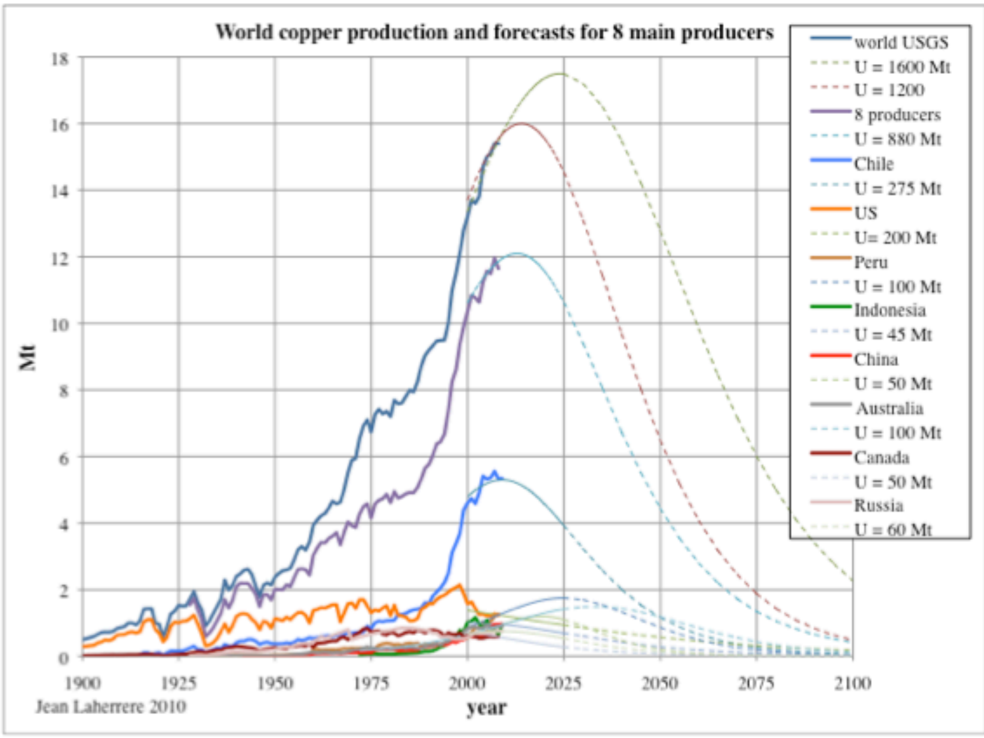
Gold and silver production had similar rise and likely similar decline for the next two decades.
Figure 67: world gold & silver annual production



-Copper peak

The world copper production will peak in the 20s, with Chile being the largest producer peaking in the 10s

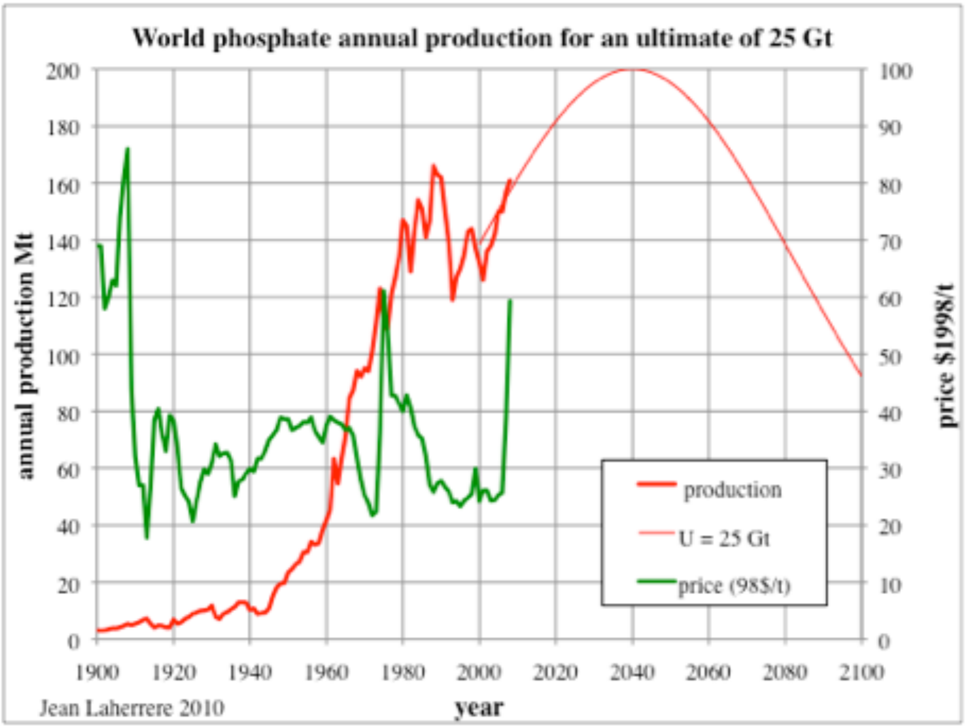
Figure 68: world copper annual production & forecasts for 8 main producers 1900-2100



-Phosphate peak

Phosphate is an important mineral for agriculture and its production will peak around 2040

Figure 69: world phosphate annual production & forecast U=25 Gt



-Population

-World population

Many papers have been written on commodity peaks, but few on «population peak»

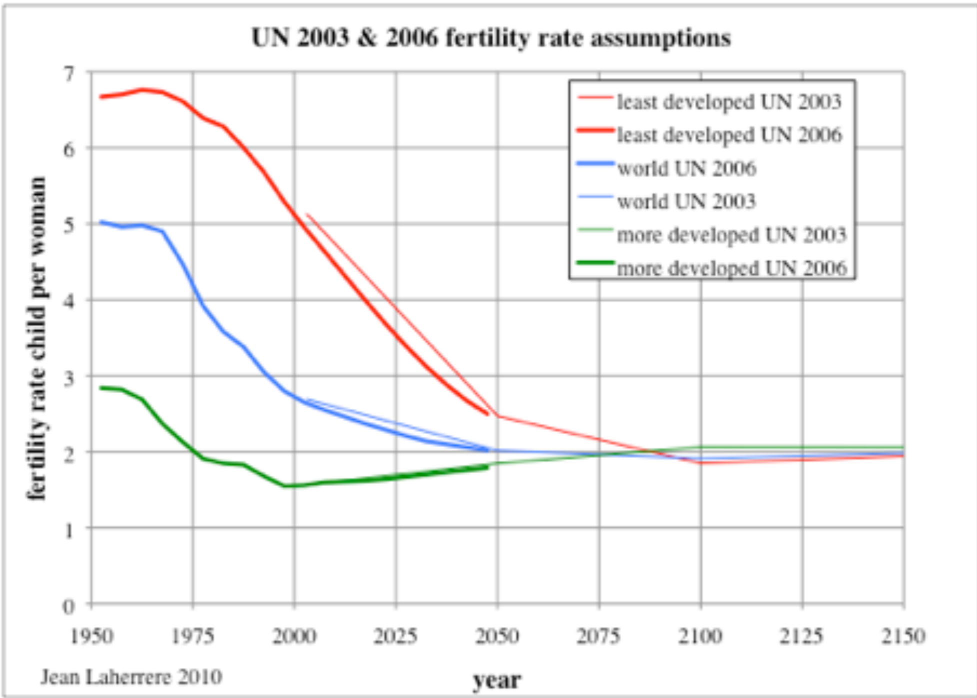
With Google (April 2010)

«peak oil» +2010	3 250 000
«peak gold» +2010	40 000

«peak population» +2010 12 900

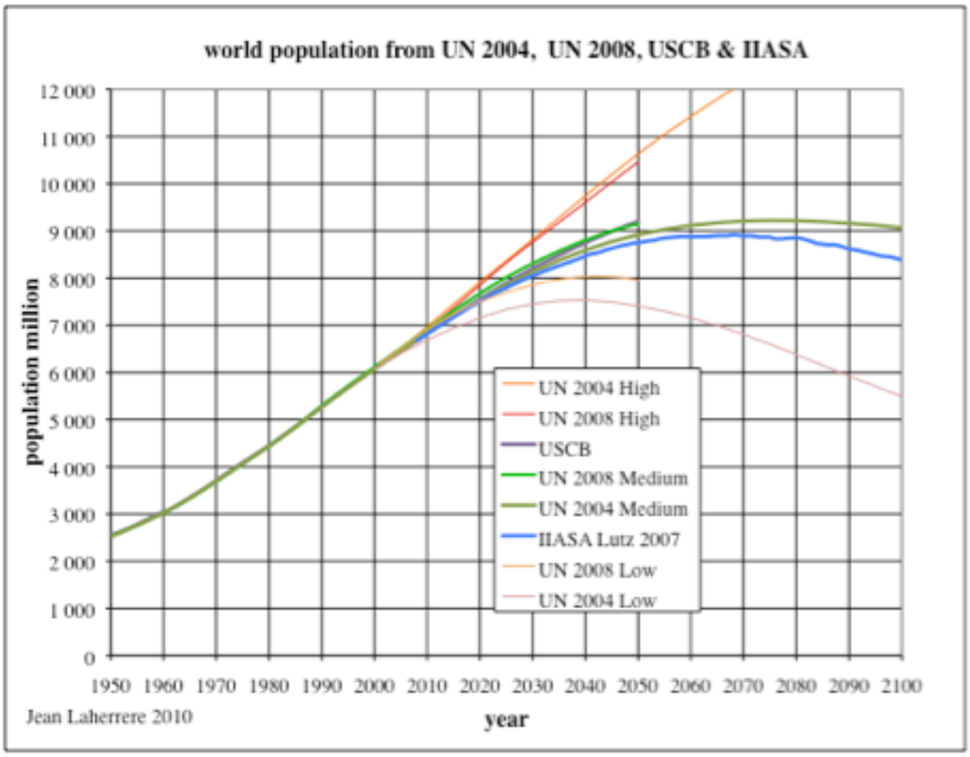
Population forecast is mainly estimated by the UN and it is based on fertility rate assumptions, which are wishful thinking. The UN goal is to have in 2300 all countries with the same fertility rate equal to replacement value of 2.05 child per woman. To achieve such goal the least developed countries (red) should have a fertility rate in 2100 less than the more developed countries (green): it is completely unrealistic. Fertility rate depends mainly upon woman education

Figure 70: UN 2003 & 2006 fertility rate assumptions 1950-2150



There are very few world population recent forecasts (UN 2008, USCB 2008, IIASA 2007), but a world population peak is forecasted around 2065.

Figure 71: world population forecasts from UN 2004, UN 2008, USCB & IIASA



The W.Lutz (IIASA) forecast displays probability for the world population peak occurring 10% in 2040 and 90% before 2090 http://www.iiasa.ac.at/Research/POP/proj07/index.html?sb=6
Figure 72: uncertainty distribution of world population from W.Lutz (IIASA)
Article from IIASA's Options (Winter 2007)

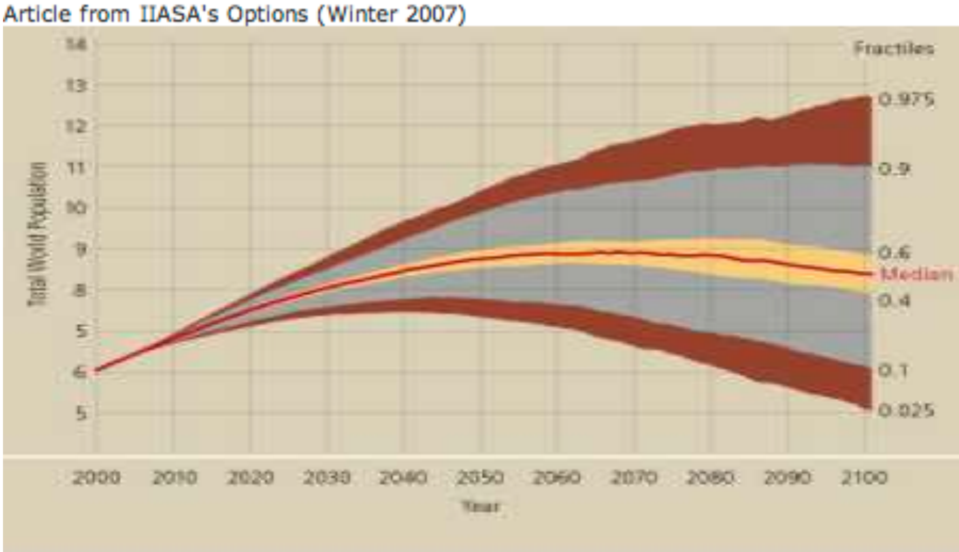


Figure 1. Uncertainty distribution of total world population to 2100, in billions.

Lutz et al 2008 « Global and Regional Population Ageing: How Certain Are We of its Dimensions? » http://www.iiasa.ac.at/Admin/PUB/Documents/IR-08-015.pdf gave the probability of population peak by continent. Latin America population peak is likely to occur around 2090 (just before Sub Saharan Africa!) and Europe peak around 2030!
Figure 73: probability of population peak by continent from Lutz

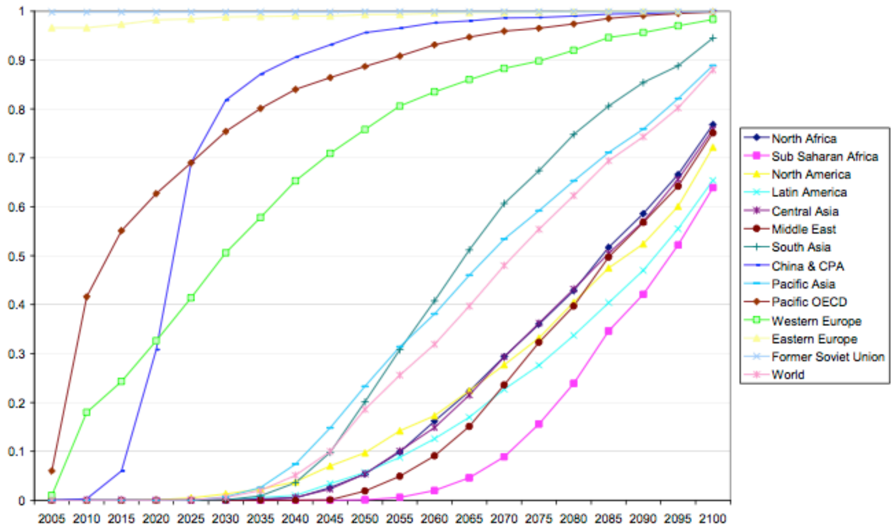
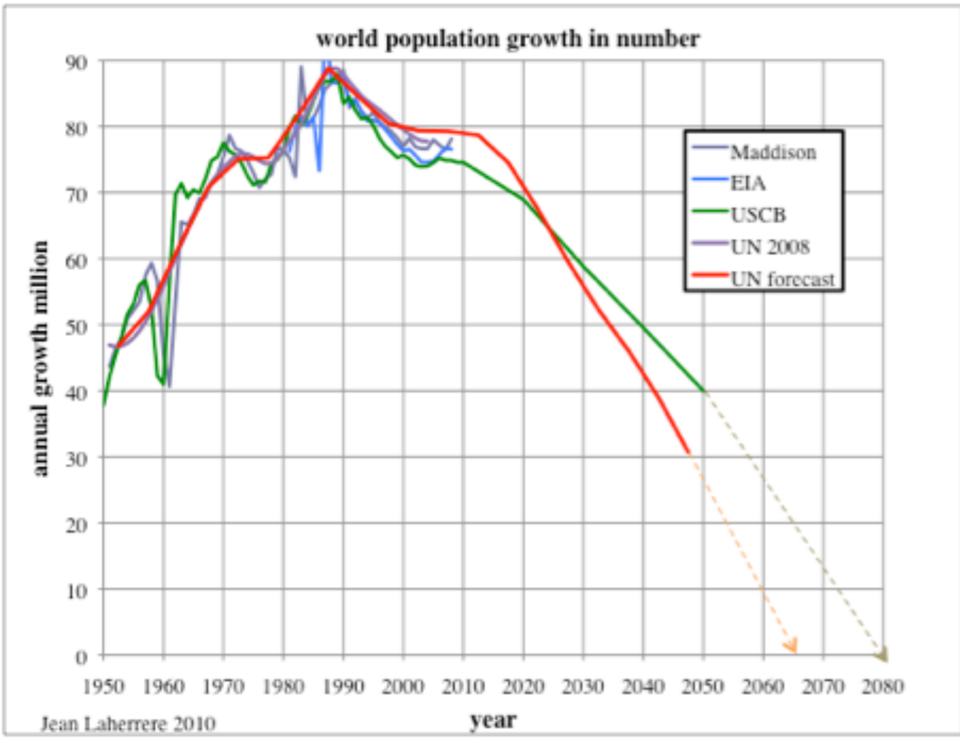


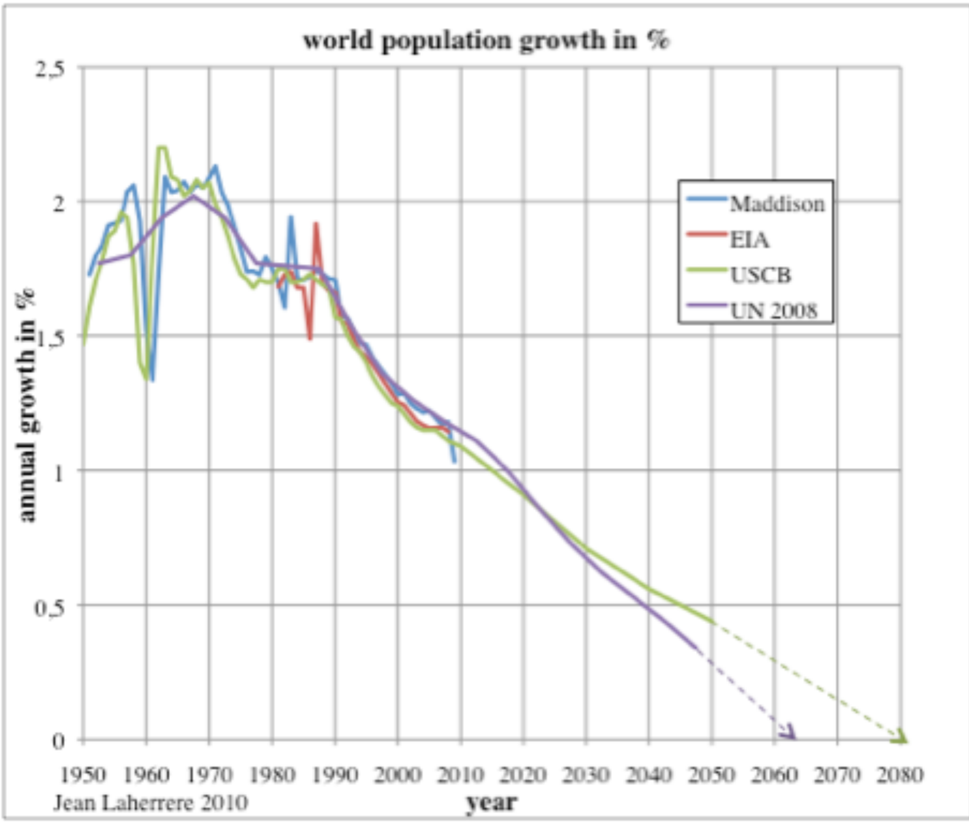
Figure 3. Probability that global and regional populations will reach a peak by the indicated date.

But instead of using assumptions on fertility rates like the UN, the extrapolation of population growth can be used, as it is for commodities (Hubbert linearization).
The problem is that population counts are as unreliable as oil reserves. Many countries cheat and there is a lot of unknown. Measuring the population of a country is difficult and census is unreliable for many reasons. Some countries overestimate to appear strong; some countries underestimate the illegal immigration. In 1990 the UN reported Nigeria with 120 millions and the following census showed that this value was overestimated by 30%. It was announced throughout the media that the sixth billion child was born on October 12, 1999. It is a joke. They don't have any idea of the

accuracy of their estimates, or it is just a political misinformation. The accuracy on population even with census is over 3% and many countries have no census.
Angus Maddison has a site reporting population and GPD per country since year 1. The other sources are the UN and USCB, also the PRB for the recent years.
Population growth can be plotted several ways: in million or in percentage, versus year or versus population.
The world population growth in million has been plotted since 1950. The trough in 1960 represents the famine in China. Since 1988 the growth declines linearly up to 2003, but since 2003 the growth is flat or increases. The forecast by USCB or UN 2008 could be extrapolated towards a peak either in 2065 or 2080
Figure 74: world population growth in millions versus time

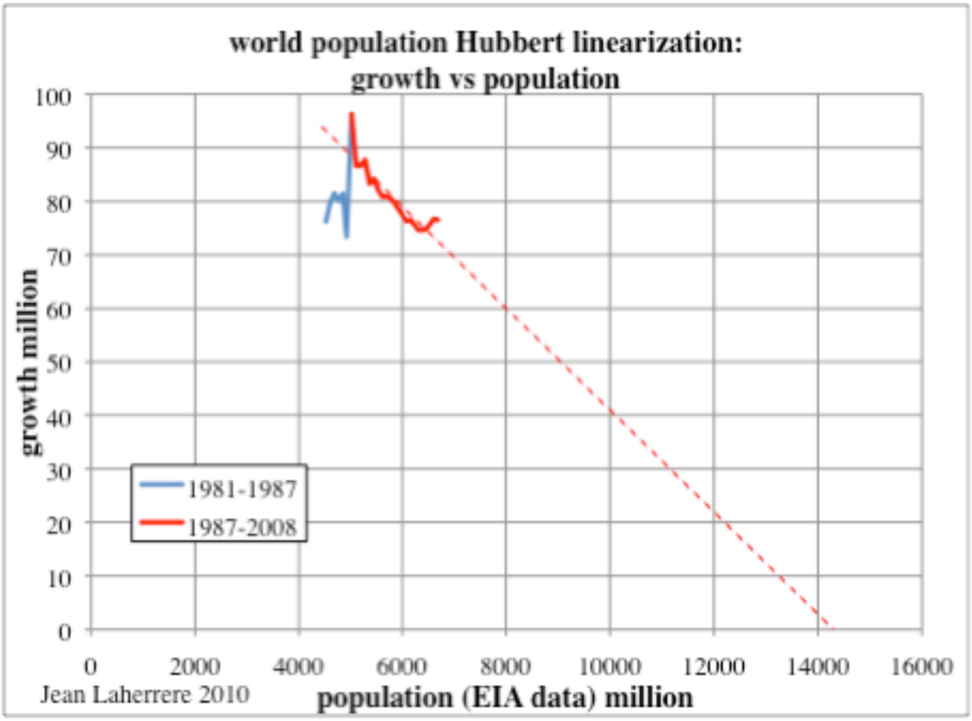


The world population growth in percentage is also crooked and could be extrapolated to 2065 or 2080, yet being unreliable!
Figure 75: world population growth in percentage versus time



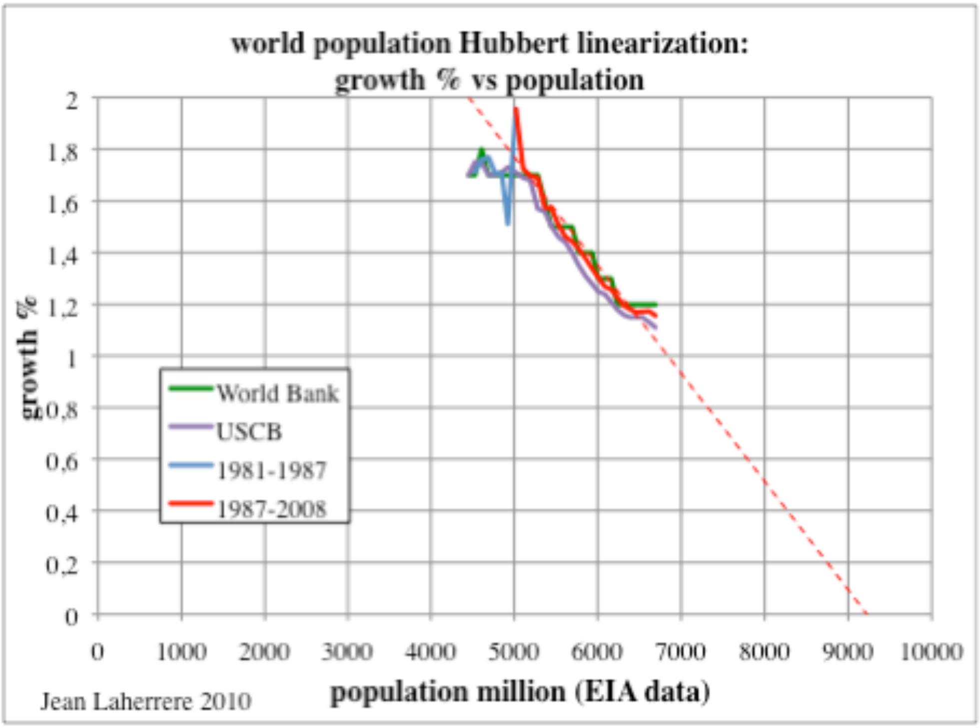
The growth in million versus population has declined linearly since 1987, except the last 4 years and can be extrapolated towards the unrealistic 14 G!

Figure 76: world population growth in million versus population for the period 1981-2008 from EIA data



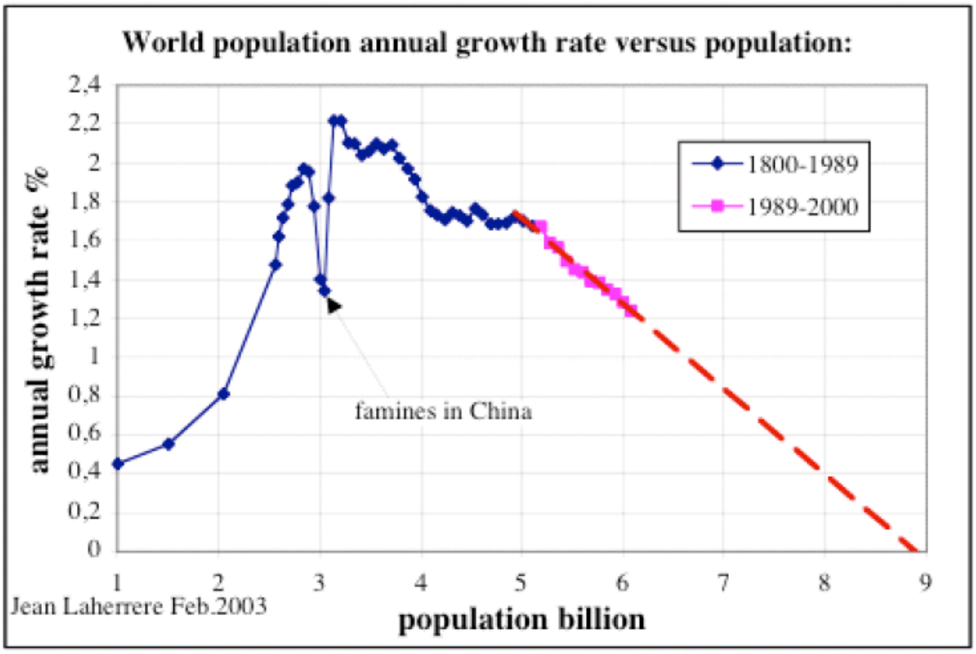
The growth in percentage versus population can be extrapolated from 1987 towards the more realistic 9 G! But the last year's data make this plot uncertain!

Figure 77: world population growth in % versus population for the period 1981-2008 from EIA data



The plot for the period 1800-2000 in 2003 looked better and simpler. But linear trend usually does not stay long! Paul Valery wrote: *What is simple is false and what is not is useless!*

Figure 78: in 2003, world population growth in % versus population for the period 1800-2000

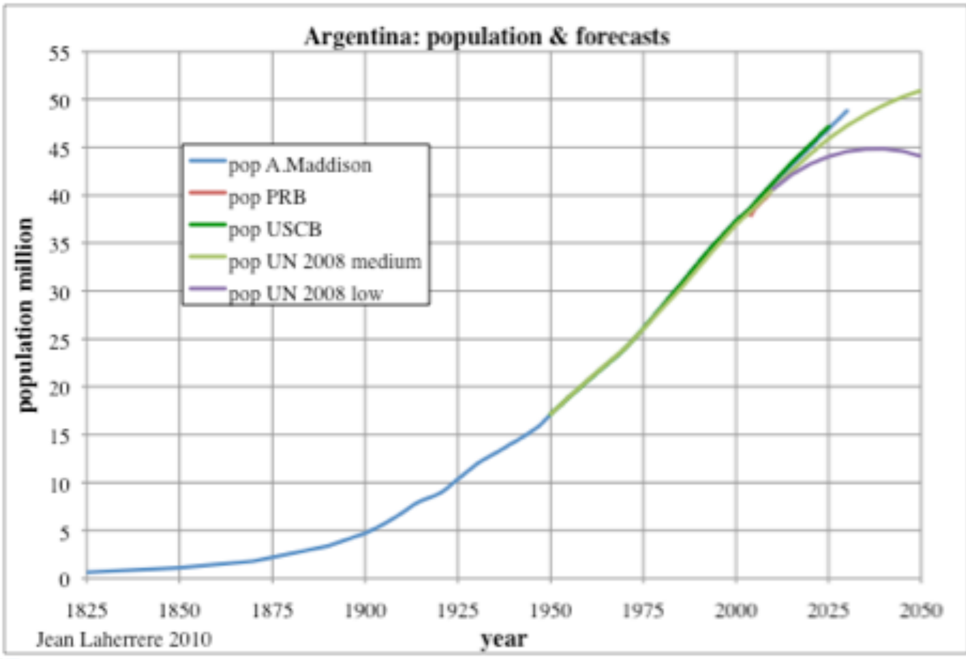


-Argentina population

When does Argentina population peak?

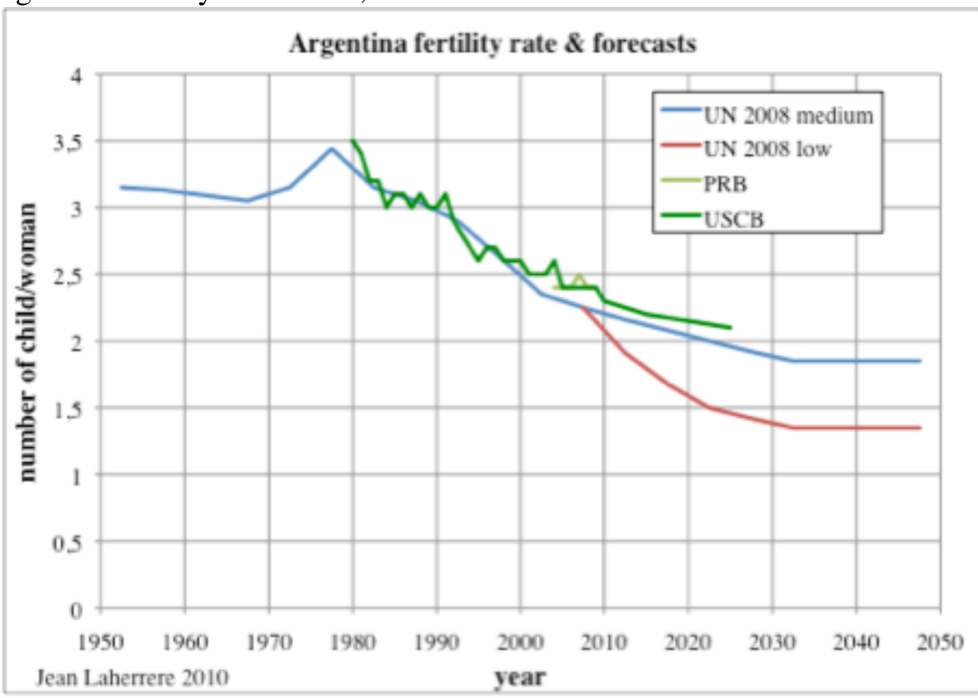
UN 2008 forecasts for the medium scenario put the population peak beyond 2050, but the low fertility scenario puts it around 2040

Figure 79: Argentina population & forecasts



The Argentina fertility rate has been declining since 1978, but the data is uncertain looking at the discrepancy between PRB and UN data.

Figure 80: Argentina fertility rate & UN, USCB forecasts

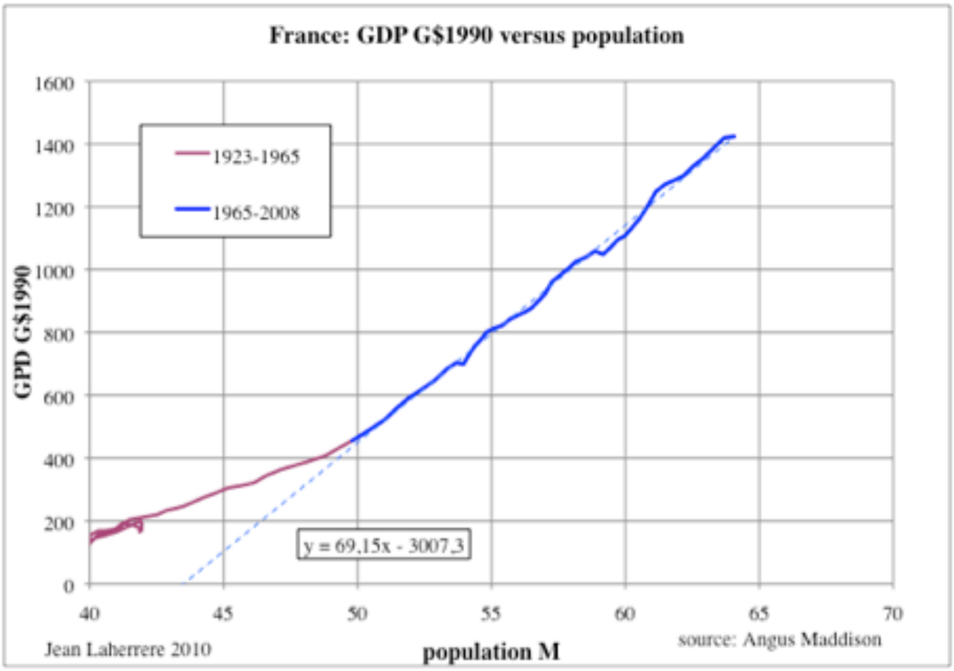


-Population: GDP and Happiness

Politicians are judged on the growth of GDP. But GDP represents expenditures and not wealth of the country. GPD is completely different from the well-being (or happiness) of the people, but there is no world consensus on the definition for well-being!

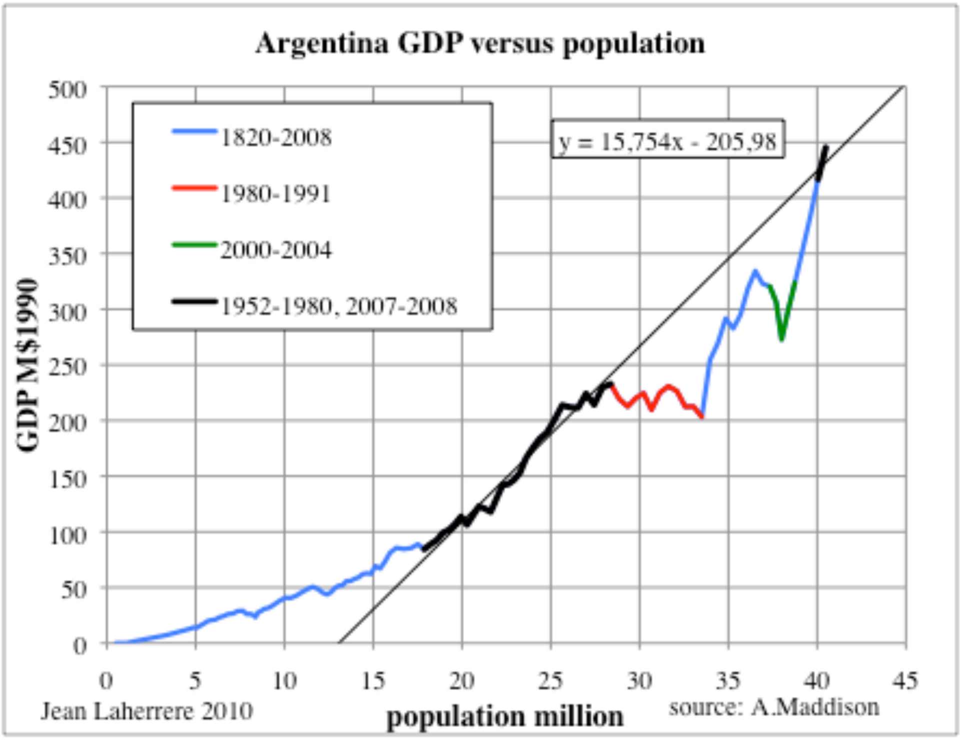
It is interesting to find that the plot of GDP versus population displays a linear trend for France, which is surprisingly the same slope as the US slope for the period 1980-2008

Figure 81: France GPD ($1990) versus population



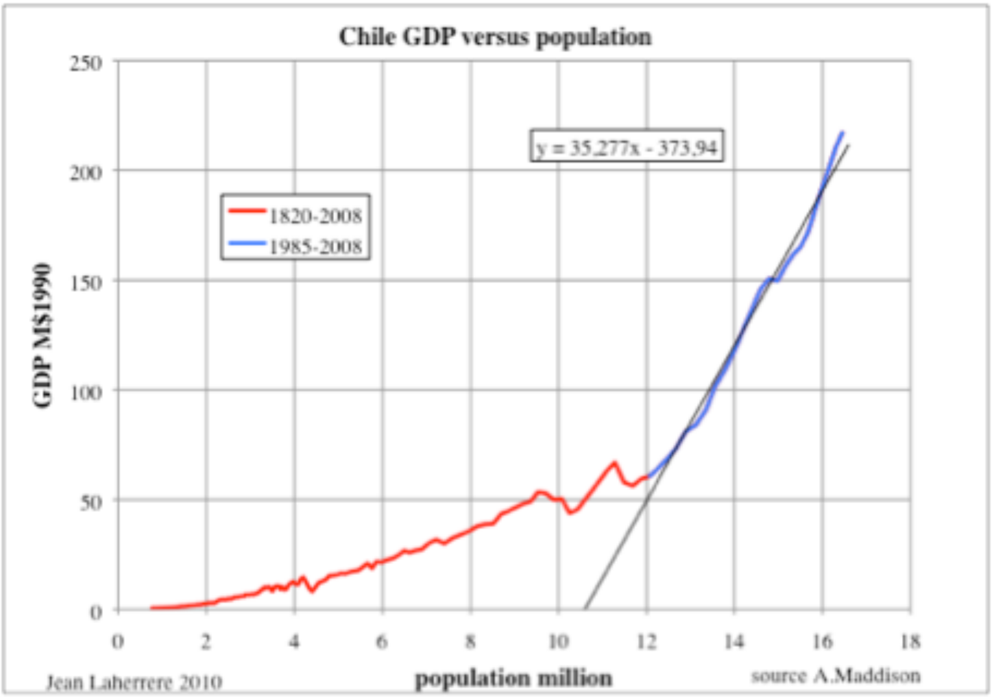
Argentina GDP versus population could display a linear trend when excluding the period from 1980 to 2007

Figure 82: Argentina GPD ($1990) versus population



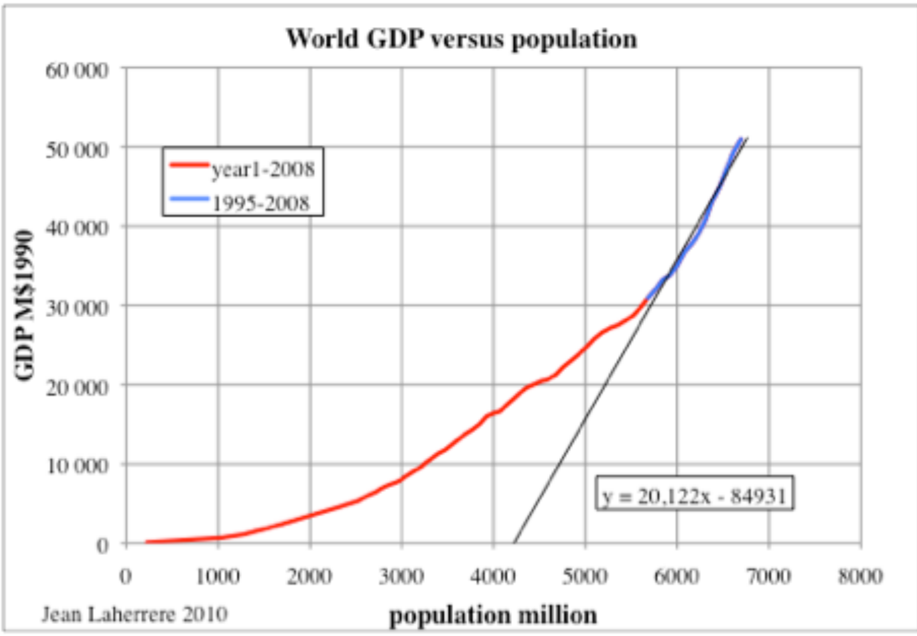
Chile displays a linear trend from 1985 to 2008

Figure 83: Chile GPD ($1990) versus population



Brazil displays a linear trend from 1965 to 2008
Figure 84: Brazil GPD ($1990) versus population

The world plot is obviously a parabola and the linear trend in the recent years is in fact a tangent to the parabola
Figure 85: world GPD ($1990) versus population year 1 to 2008

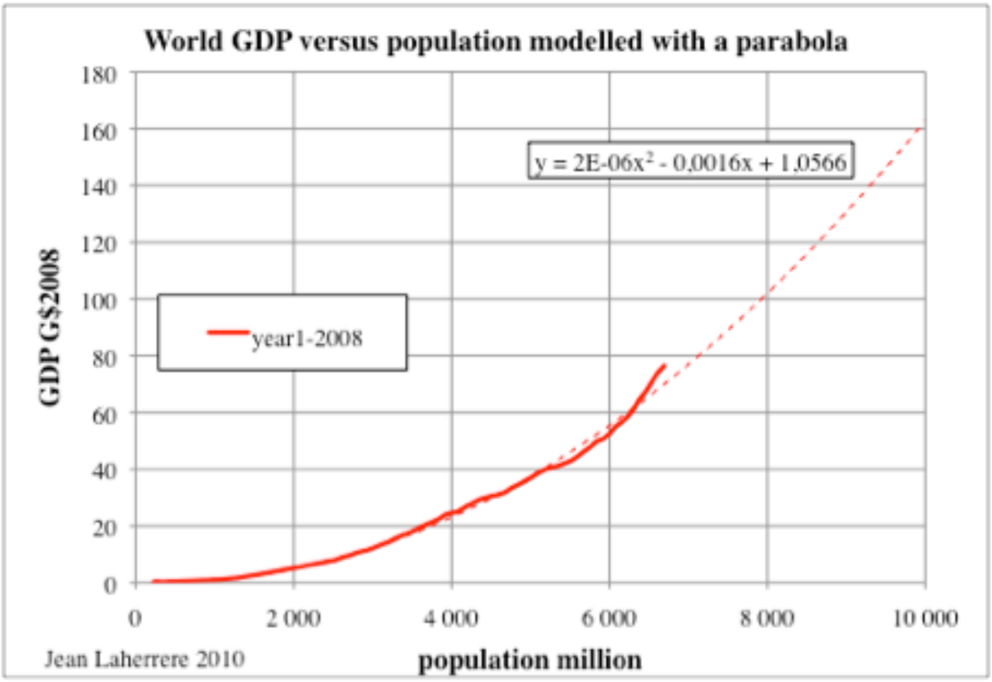


The comparison of the last linear trend of GDP increase per capita in k$2008 is as follows

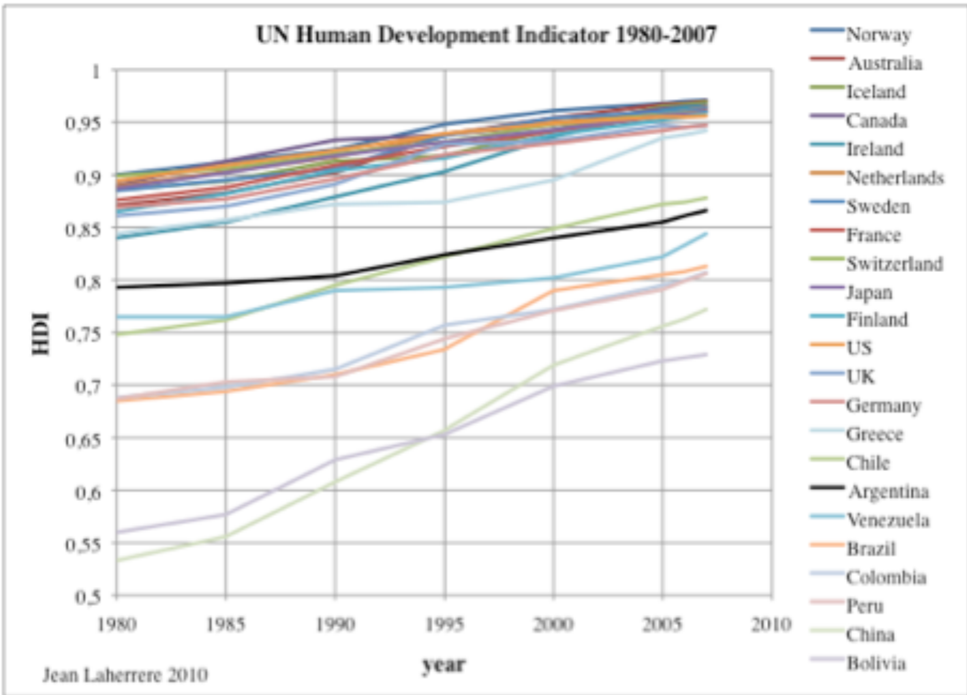
Country	linear period	k$2008/capita
India	1992-2008	11
Brazil	1965-2008	12
Argentina	1952-1980, 2008	24
world	1995-2008	27
Chile	1985-2008	53
Portugal	1993-2008	95
Australia	1990-2008	95
France	1965-2008	104
US	1980-2008	104
China	2000-2008	114
Canada	1992-2008	117
Holland	1982-2008	131
Switzerland	1995-2008	132
Germany	1990-2005	158
Denmark	1985-2008	174
Norway	1970-2008	189
UK	1970-2008	231
Belgium	1969-2008	261
Italy	1977-2008	351
Spain	1993-2008	569

The world GPD in $2008 is easily modelled with a parabolic curve. As world population is likely to peak at about 9 G habitants, GDP should peak around 140 G$2008, about the double of today's GPD.

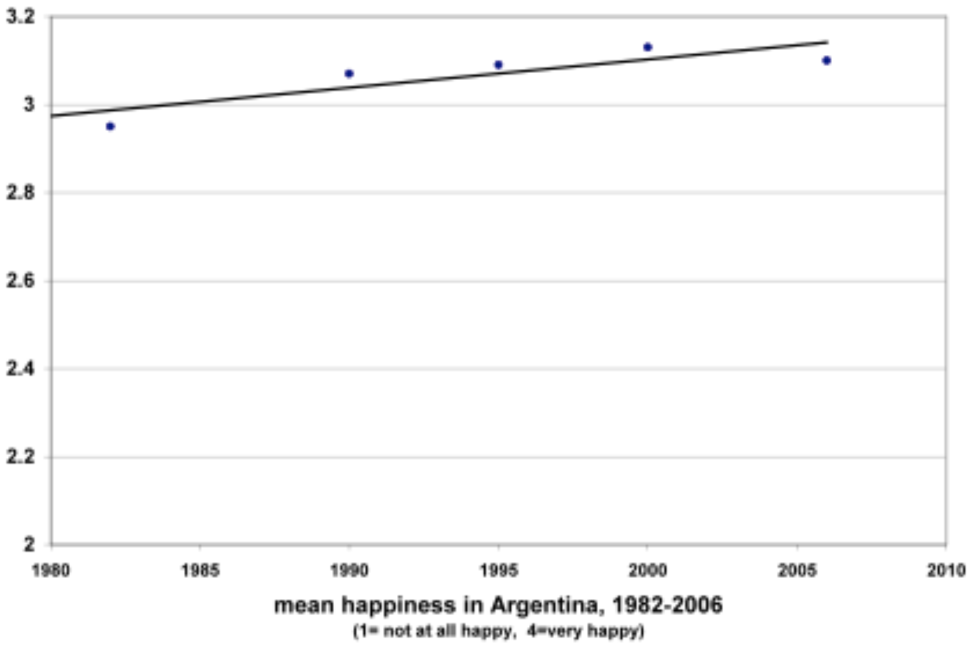
Figure 86: world GPD ($2008) versus population year 1 to 2008 modelled with a parabolic curve



It is known that GDP is manipulated, mainly by using a hedonic factor to deal with computing investments.
It is obvious that politicians will continue to favour population growth as long as GDP will be the indicator on which their action is judged.
Because population growth leads to consumption growth and that constant growth is impossible in a finite world, it is necessary to break this trend by changing our indicator.
GDP should be changed and replaced by a well-being and happiness indicator.
The problem is that there is no consensus on the happiness indicator and measures vary largely!
The Gross National Happiness was introduced in 1972 in Bhutan, but dealing with too many subjective items.
In France, on the request of President Sarkozy, the Stiglitz-Sen commission has made recommendations to replace GDP by an indicator based on well-being, quality of life, security, and environment. But no much has been done since!
The UN Human Development Indicator HDI put in 2007 in first rank Norway followed by Australia and Iceland.
It is surprising that the HDI seems always on the rise, not decline, no peak!
It is likely that Iceland rank in 2010 will be lower and will display a peak (like Greece)
Figure 87: UN Human Development Indicator for some countries from 1980 to 2007



Australia is second rank in HDI and rising, but Inglehart (« Happiness trends in 24 countries 1946-2006 » using Ruut Veenhoven data (http://worlddatabaseofhappiness.eur.nl/) has found that Australia happiness is rather on the decline from 3.5 in 1950 to 3.25 in 1980 & 2007.
Inglehart found that Argentina happiness did increase up to 2002 at 3.15.
Norway happiness is not too far being at 3.2, Great Britain being at 3.4!
Figure 88: Argentina happiness from Ruut Veenhoven, Erasmus University Rotterdam



Veenhoven did a survey on satisfaction with life (scale 1-10) in 146 nations from 2000 to 2009 and found the following ranking, with Costa Rica on first rank!

Rank	Nation	Satisfaction with life scale 0-10
1	Costa Rica	8,5
2	Denmark	8,3
3	Iceland	8,2
4	Switzerland	8
5	Finland	7,9

6	Mexico	7,9
7	Norway	7,9
8	Canada	7,8
9	Panama	7,8
10	Sweden	7,8
11	Australia	7,7
12	Austria	7,7
13	Colombia	7,7
14	Luxembourg	7,7
15	Dominican Republic	7,6
16	Ireland	7,6
17	Netherlands	7,6
18	Brazil	7,5
19	New Zealand	7,4
20	United States	7,4
21	Argentina	7,3

UK was on rank 31 with 7,1 and France ranked 47 with 6,6

But the New Scientist published a study in 2003 where the happiest countries were Nigeria, Mexico, Venezuela, which are rank 80, 6, 26 in Erasmus study, in total contradiction.
New Scientist found that happiness levels have remained virtually the same in industrialised countries since World War II, although incomes have risen considerably.

It is obvious that measuring happiness is very difficult, too chaotic and without significant change in industrialised countries to be a genuine indicator.
I am afraid that GDP will continue to be used by lack of good substitute.

-Conclusions
Since centuries, progress was found by going west to new territories. But today there is no more new land to occupy. We are finding that the world is limited, like its resources.
Peaks are occurring in many domains.
Growth was expected in Business As Usual scenarios. But constant growth is impossible in a limited world.
Many do not want to change their way of life and deny that peaks are occurring.
We do not like to remember that we are all mortal.
Peak means decline, but decline does not mean death.
We all peak when being adult. We start to realise our decline when, around 45 years old, we need spectacles. But our life expectancy is then about 35 years, and retirement is a good period of life!
Peaking is not catastrophic, it is only part of life and we have to accept it.
We have to change our way of life and more important our way of thinking.
Instead of pushing consumption and waste, we have to find better ways to consume less and better.
The first thing is to recognize that peaks have occurred and many more are coming.
The best examples are the UK coal peak, the Pennsylvania anthracite peak, the USL48 oil peak, and the North Sea oil peak.
Peaks are reality and not theory!