ENERDATA s.a.

ECN
energy-innovation

VLEEM 2

MID-TERM ASSESSMENT REPORT

Annex 3

Modelling impacts of demographic evolution on macro-economics: formula and preliminary results

1 Modelling demography for the 21th century: preliminary results

According to the story lines for sustainable development scenarios provided by ECN and ENERDATA[1], three different demographic scenarios have been described:

- HiPop with a fertility assumption of 2.5 children per woman in 2100.

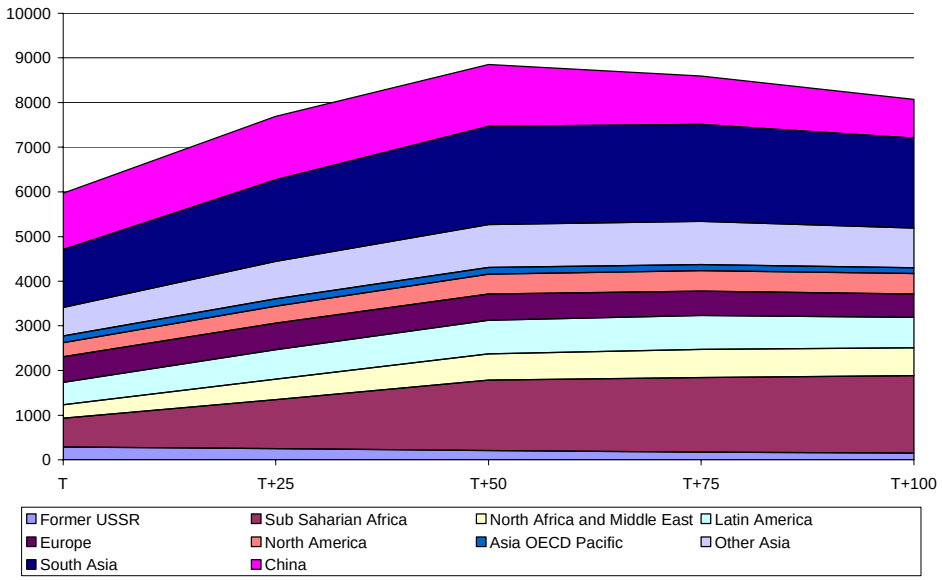
- MidPop with a fertility assumption of the "Medium variant" of the United States projections until 2050 and a continuation of the trend for the developed regions until 2010 and a stabilisation of the decrease in the fertility rate for the developing regions.

- LowPop with a fertility assumption of 1.2 Children per woman in 2100.

It is necessary to note that these precise assumptions of 2.5 and 1.2 children per woman could change during the next phase of the work. The aim of this first run of the model is only to provide first results to illustrate the story lines. The elaboration of the final scenarios is the aim of the next year work.

The MidPop scenario traduce a complete demographic transition in most part of the world by 2050 with a peak of the total population to 9 billion and a slow decrease of the population to 8 billion people in 2100, induced principally by the strong decrease of the population in China (**Figure 2**). In this scenario the share of African population increase from 16% to 29% and those of South Asian countries from 22 to 25% whereas the share of Chinese population decrease from 21% to 11% and those of European region from 10 to 6%. The share of the other regions remains rather stable.

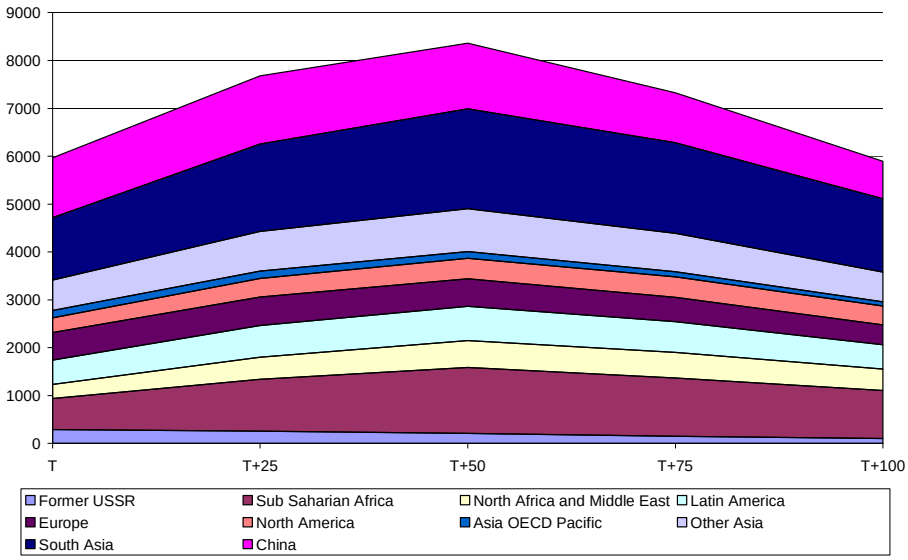
Figure 1 : World population projection for the MidPop Scenario



[1] See the document "Story lines for sustainable development scenarios", Koen Smekens (ECN) and Bertrand Chateau (ENERDATA)

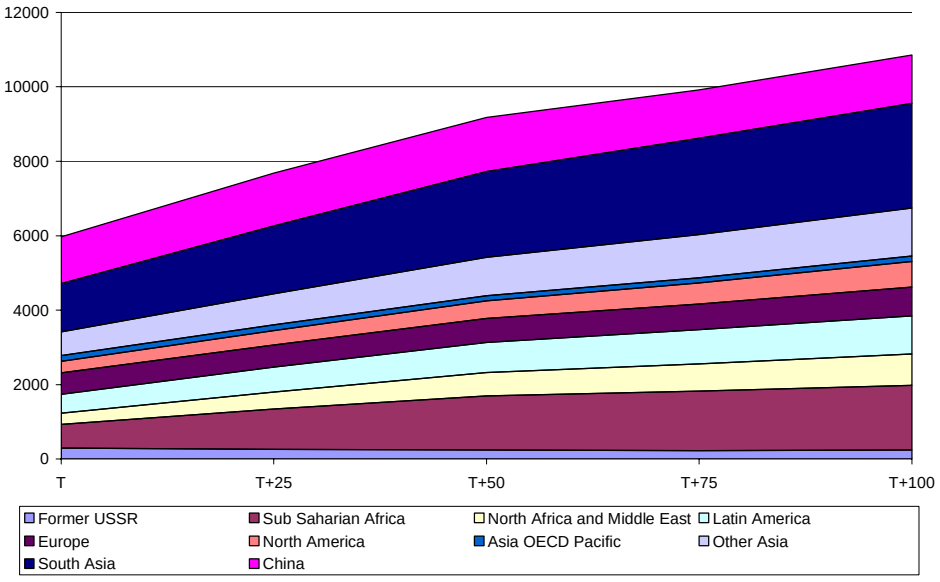
The LowPop scenario simulates a peak of the population to 8 billion people in 2050 and a rapid decrease to 6 billion people in 2100. In this scenario the share of each region remains more stable than in the MidPop scenario (**Figure 3**). The share of the African regions rises from 16% to only 26% whereas those of China decrease only from 21% to 13%.

Figure 3 : World population projection for the LowPop Scenario



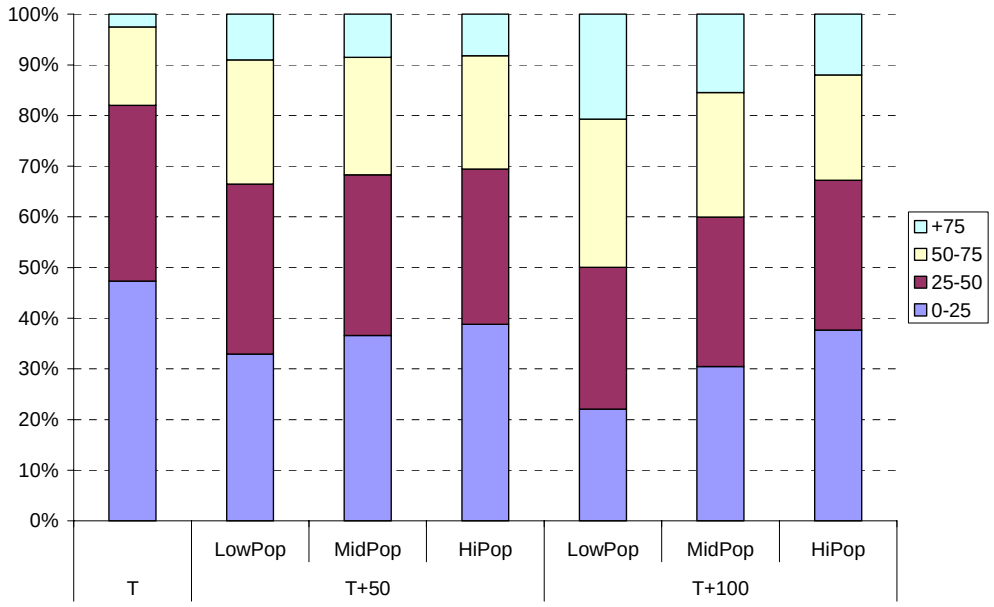
The HiPop scenario simulates a population of about 11 billion people in 2100 with a high growth of the population by 2050 and a slowdown after during the 50 next years. It provides an increasing share of the African regions to 25% in 2100 and a decreasing share of Chinese population to 12%.

Figure 4 : World population projection for the HiPop Scenario



All the three scenarios traduce an important population aging in the 100 next years. Indeed, the share of the population after 50 years old could increase from about 20% in 2000 to between 30% and 50% depending on the scenario; the MidPop scenario simulating a rate of about 40%.

Figure 5: Repartition of the world population by class of age for each scenario



The methodology of the model being validated during the first phase, the work for the next step will be essentially to choose some more precise assumptions for each scenario; some implementation could also be done to the model but in a marginal way.

2 Macro-economic equilibria and actual growth of production and wealth: formula

Macro-economic equilibria

$Y = C+I+S$

$Y = M+A+Iin+S$

$C = Cm+Ca$

$I = Im+Ia+Iin$

$M = Cin+Iin$

$A = Ca+Ia$

$Y = W+Rb+Pe$

$Rb = Rn+T$

Y : Gross Domestic Production
C : Consumption
I : Investment
S: Other
M: consumption + investment households
A: consumption + investment administration
Iin: Investment industry
Im: Investment households
Ia: Investment administration
Cm: Consumption households
Ca: Consumption administration
W: Salaries
Rb: Gross result
Pe: Profit to/from foreign world + import taxes
Rn: Net result
T: Public transfers

Population structure & equilibria

$M = pop \times \overline{M}$

$\overline{M} = \sum_i pop_i / pop \times \overline{M_i}$

$W = E \times \overline{W}$

$\overline{W} = \sum_i E_i / E \times \overline{W_i}$

$T_p = \sum_i pop_i / pop \times \overline{T_{pi}}$

$T_p = T - A$

pop : population
$\overline{M}$: households consumption+investment per person
(i): age class.
$\overline{W}$: average salary per year per employee
E= number of employees
T_p : transfers among and to households
$\overline{T_p}$: average transfers among and to households per person

Savings and Financial equilibria

$\overline{S_i} = \overline{W_i} \times E_i / pop_i + \overline{Tp_i} - \overline{M_i}$

$S = \sum_i \overline{S_i} \times pop_i$

$B = S + F$

B: overall balance of payment
S: household savings
$\overline{S}$: households savings per person
F: other financial flows

$$I_i = Rn + Pe - F$$

Macro-economic dynamics

$$Y_t = PY_t \times Ll_t$$

$$E_{plt} = E_{t-i} + \left(\frac{(Iin_t + Iin_{t-i})/2 - \min Iin_t}{Ic_i t} \right)$$

$$Ll_t = (popact_t - E_t)/popact_t \geq U\min, t$$

$$Ut \leq U\max t$$

$$PY_t = PY_{t-1} \times popact_t / popact_{t-1} \times H_t / H_{t-1} \times (Q_t / Q_{t-1})^{\alpha}$$

$$I_{c,t} = I_{c,t1} \times (Q_t / Q_{t-1})^{\beta}$$

PY: potential gross domestic production

E_t : employment, year t

E_{pt} : potential employment year t

H_t : paid working hours per year per employee

Q_t : information level, year t

$\min Iin, t$: Minimum investment to maintain employment, year t

Ic, t : Investment necessary to create 1 million paid jobs, year t

$popact_t$: Active population, year t

$U\min, t$: Technical minimum of an employment ration, year t

$U\max, t$: Maximum socially acceptable unemployment ration, year t

$Ipind, t$: Potential investment year t

Demographic structure and macro-economics: diagram