System Dynamics Modeling of Impacts of Central African Republic Refugees in Eastern Region of Cameroon

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Abstract

This paper portrays a System Dynamics (SD) approach, in which we study the effect of Central African Republic (CAR)' refugees in the eastern part of Cameroon, as observed since 2005. We analyze and study the refugees' dynamics through their displacement from the arrival point at C.A.R-Cameroun frontier until the eventual self-reliance inside Cameroon territory. The use of SD is to advance practical comprehension of complex refugees' system and to evaluate their impacts on the hosting regions. SD can detect how structure and decision policies engender system behavior known as problematic and cope with the complexity of humanitarian issue. The simulation allows us to grasp the complex interrelation and the pattern of the refugees. The models are the inherent involvement of individual constituents of stocks. We highlight the heterogeneity of refugees' coflow and display the attributes of stocks. Coflow underscores the evolution of the component, which gives an opportunity to maintain aggregate measure of heterogeneous population of refugees without evidently disaggregating them. Subscripts are used for formulating the aging chain.

Keywords: *Cameroon, CAR, Coflow, System Dynamics, Refugees, Aging, Self-reliance, Subscript.*

1. Introduction

Sub-Saharan Africa is continuously subject to major refugees crisis due to wars (e.g. Angola, Sudan, Chad, Rwanda, Democratic Republic of Congo, Somalia, Central African Republic) and Climate change. Neighboring countries already facing big social and economic challenges have to manage significant inflows of refugees and the associated humanitarian, security, social and economic issues. "Host country is compelled to stretch its resources beyond limits to accommodate the new arrived" (Akokpari, 1998).

How sub-Saharan countries can strengthen their capacity to handle the complex socio-economics dynamics resulting from refugee inflow in a way to preserve stability and achieve a level of self-reliance and independence for both refugees and the host population?

We proceed with system dynamic modeling as a useful tool allowing sub-Saharan states to have a holistic and dynamics assessment of the impact of refugees in the hosting regions. Therefore, they can also design efficient policy response.

In this respect, with use of system dynamics we study the demographic and social impact of refugee inflow from Central African Republic (CAR) in the East Region of Cameroon as follows:

- Capture the dynamics of demography and food access resulting from the refugee inflow in the eastern region of Cameroon
- Understand the dynamics of refugees settlement from their arrival to their integration into the local population
- Assess the impact over time of refugee inflow on the social infrastructure such as

education, healthcare, drinking water access and sanitation access.

2. Context of CAR refugee

2.1. Causes of CAR refugee's inflow into Cameroun

Located in the east of Cameroon and on the north of Democratic republic of Congo, Central African Republic (CAR) is subject to political instability and violent armed rebellion since the seizure of power by the former president François Bozizé in 2003. The situation in CAR worsened since 2012 with the emergence of SELEKA rebels coalition that toppled Bozizé Regime in March 2013. In December 2013, violence dramatically escalated with the fighting back of "ANTI-BALAKA" forces opposing to SELEKA.

The overall instability led to massacres of civilian and human right abuses and an internal displacement of half million of the population (around another half million fleeing in neighboring countries such as Cameroon, Chad and Democratic Republic of Congo).

2.2. Study area

Republic of Cameroon is situated on the Gulf of Guinea and the Atlantic Ocean within the equatorial and tropical region of Africa. It is in the West Central Africa region and surrounded by four countries (Figure 1): the Central African Republic (CAR) to the East, Chad to the Northeast and Equatorial Guinea, Gabon and the Republic of the Congo to the South. It contains relatively natural resources and lands especially for agriculture. Cameroon has a surface area of 475,442 km^2 and its population is estimated of 23,130,708 inhabitants (CIA WORLD FACTBOOK, 2014).

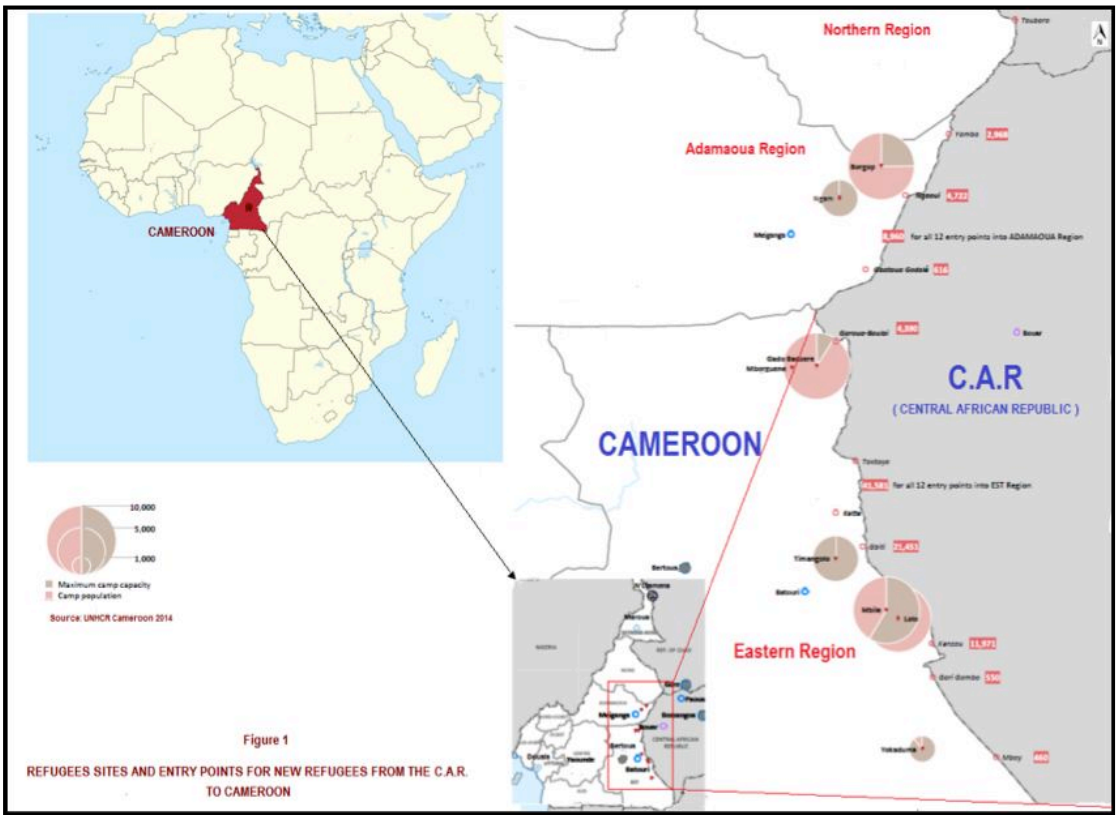


Figure 1. Cameroon and Eastern Region

In Cameroon, 60% of the active populations are farmers whose main economic activities accounting

for close to 20% of Gross Domestic Product (GDP) are farming and raising livestock. Besides, the farmers produce over 80% of the food consumed across the country. According to the Human Development Index (HDI - 2014), Cameroon is economically among the group of Heavily Indebted Poor countries and ranked 152th out of 187 countries (United Nations Development Programme, 2014).

Cameroon is suffering a double refugee crisis. Influxes of refugees from both Nigeria and CAR are putting pressure on very limited local resources. In spite of the fact that Cameroon is peaceful, the ongoing instability in the neighboring regions (Boko Haram in Nigeria, civilian war in CAR) has caused a huge inflow of refugees and asylum-seekers in Cameroon. In that setting, in July 2005, Cameroon adopted a Law defining the legal framework for refugees' protection, which was brought into application by a decree signed in November 2011 **(**UNHCR, 2014). The big picture is that Cameroon currently hosts over 268 thousands people of concern to United Nations High Commissioner for Refugees (UNHCR Global Appeal, 2015).

As of end of December 2014, UNHCR reported 233 thousands refugees from CAR in Cameroon, with around 150 thousand of them located in East Cameroon Region, one of the poorest Regions of Cameroon. In 2007, 50 percent of the population was living under the poverty line. In 2010, only 25 percent of the population had access to drinking water, there were just 6 nurses for 10,000 inhabitants and 6 doctors for 100,000 inhabitants.

The eastern region of Cameroon has experienced a brutal increased of its population by around 15 percent between the beginning of 2013 and end of 2014 due to huge refugees' inflow from Central African Republic (UNHCR, 2014). The demographic chock mixed with the limited resources and poor healthcare and education capacity has plunged the eastern Region of Cameroon into a humanitarian crisis. This issue concerns not only refugees but also many in the local population.

3. Why we use system dynamics modeling?

The World Dynamics (Forrester, 1971) is well known with the aggregate representation of population, in which the model has more effects on both births and deaths.
"The SD approach provides manager with a set of tools that can help them learn in complex environments. These tools include causal mapping, which enables managers to think systemically and to represent the dynamic complexity in a system of interest, and simulation modeling, which permits managers to assess the consequences of interactions among variables, experience the long-term side effects of decisions, systematically explore new strategies, and develop understanding of complex systems" (Gonçalves, 2008).

Refugee inflow in East Cameroon Region generates a complex social and economic system with important feedback processes, accumulations, delays and non-linear relationships. Certainly, the objective of the modeling is to understand the structure and the associated behavior of the system resulting from the refugee inflow in East Cameroon. Therefore, it will allow Policy makers and humanitarian relief managers to determine the best way to improve living conditions for both refugees and the local population in the eastern part of Cameroon, which is extremely poor and relies on humanitarian assistance to survive until they will be achieving a level of self-reliance. Self-reliance, this term is recent concept in the literature (Game et al 2014). Whatever we want to refer to the definition from UNHC that *"Self-reliance is the social and economic ability of an individual, a household or a community to meet essential needs (including protection, food, water, shelter, personal safety, health, and education) in a sustainable manner and with dignity."* (De Vriese 2006, Hunter 2009 and *UNHCR Handbook on Self-Reliance 2005)* and *"refers to developing and*

strengthening livelihoods of persons of concern, and reducing their vulnerability and long term reliance on humanitarian/external assistance" (Crisp, 2004).

4. The Model

4.1. The model Structure

The model focuses on:

(i) Representing the course of CAR refugees from their arrival in East Region of Cameroon to their integration into local population.

(ii) Capturing the new demographic dynamics in the region resulting from the refugee inflow into the local population.

(iii) Monitoring the evolution over time of key social indicators such as access to healthcare, to education, to drinking water and to improved sanitation.

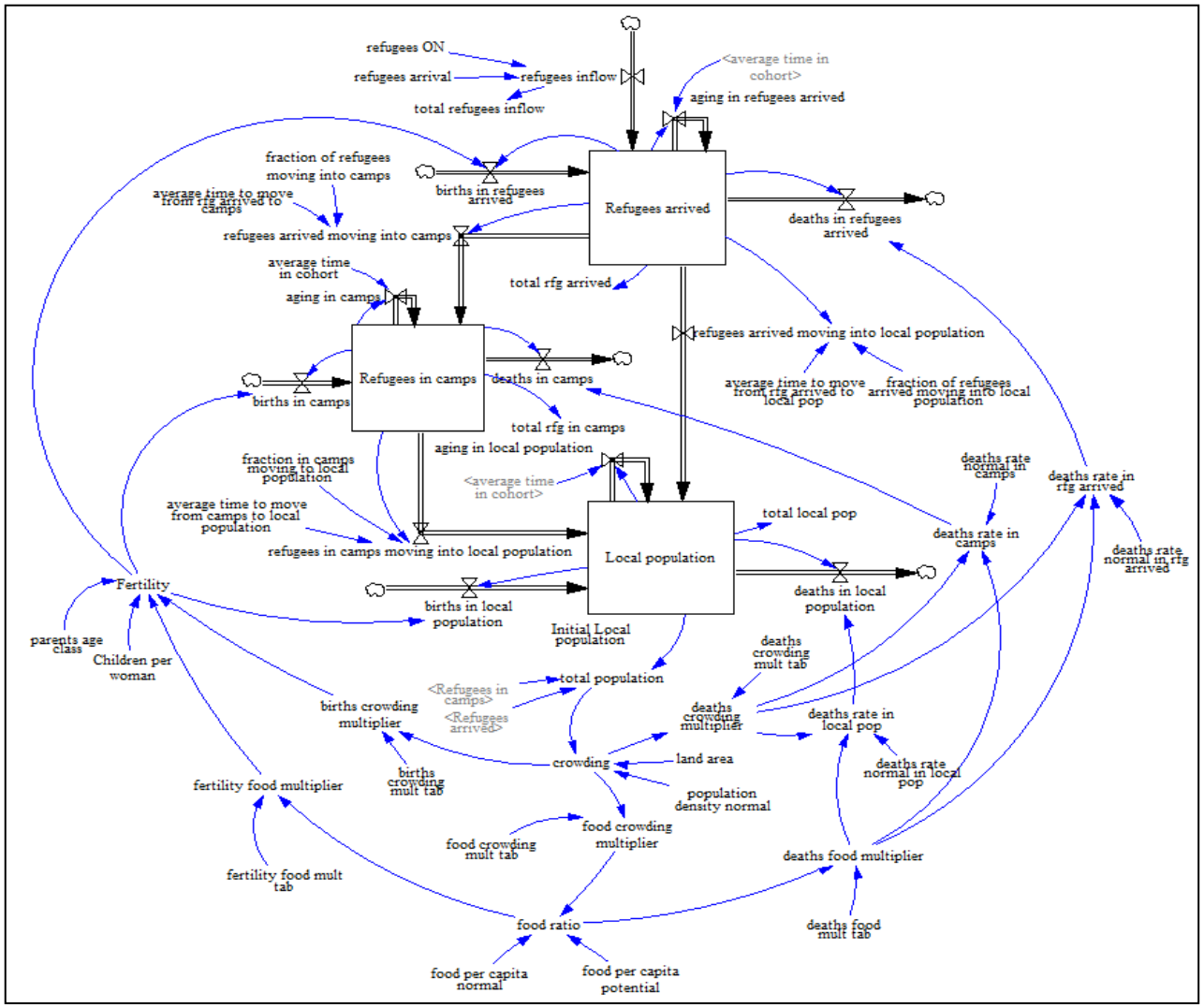


Figure 2. Stock Flow Diagram of the model

4.2. The stocks of the model

Our model is composed of three stocks variable *(Figure 2)* representing the three groups of population:

- The "**Refugees arrived**" capturing the monthly inflow of refugees from CAR in the East Region of Cameroon. Refugees fleeing violence in CAR arrived at the Cameroon border in dire

conditions. Most of them join temporary sites near the border between Cameroon and CAR where they can receive first aid from humanitarian organizations. Sometimes schools have serve as temporary accommodations for new refugees arrived. New refugees are scattered across about 300 villages near the 900km long border between Cameroon and CAR, which make it some times difficult for the relief agents to detect and provide them with first aid.

- The "**Refugees in Camps**" representing the stock of refugees transferred from temporary site near the border to the mainland in Refugees' sites allocated by the Cameroonian Government.
- The "**Local population**" in eastern Region of Cameroon hosting refugees from CAR.

4.3. Subscripts in the model

To simplify the stock flow structure of the model, we have used the subscript to represent: (i) The aging chain in each group of population; (ii) The three categories of population ("Local population", "Refugees in camps", "Refugees arrived") when necessary.

We've modelled each group of population ("Local population", "Refugees arrived", "Refugees in camps") as an aging chain composed of 4 cohorts:

- "children": age of 0 to 14,
- "parents": age of 15 to 49,
- "older": age from 50 to 65,
- "old": age from 65 and above.

The aging chain is represented by the subscript "AGE = children, parents, older, old". For example, children in the local population are expressed as "Local population [children]. This allows us to have a single stock of each group of population instead of 4 stocks for the 4 cohorts in a group of population.

We also represent the three groups of populations when necessary with the subscript: "POPULATION TYPE = ref arrived pop, ref in camp pop, local pop" representing respectively: "Refugees arrived" population, "Refugees in camps" population, "Local population". This allows to have one variable instead of three to represent certain characteristics of a Group of population such as "Children per woman", "Fertility, "Food ratio", etc.

4.4. The course of CAR refugees from their arrival in East Region of Cameroon to their integration into local population

4.4.1. From "Refugees arrived" to "Refugees in camps"

Over time, a fraction of "Refugees arrived" are transferred into Refugees sites and thus join what we called here "Refugees in Camps". The transition from arrival to camps takes time because of 3 main factors:

- "Refugees arrived" are scattered across 300 villages stretching along the 900 km border with CAR, making it difficult for relief agents to reach them.
- Refugee sites are in the mainland far from the border.
- The roads reaching refugees sites are in bad shape.

4.4.2. From "Refugees arrived" to integration into "Local Population"

Over time, a fraction of new arrived refugees from CAR merges with the local population. This is possible because:

- They have relatives already established in Cameroon.
- Some refugees have enough resources to be self-reliant at their arrival in the East region of Cameroon.

4.4.3. From "Refugees in camps" to integration into "Local population"

"Social and economic integration have been relatively successful with refugees living peacefully among Cameroonians and at a comparable standard of living. UNHCR's and implementing partner NGO approaches in Cameroon have contributed to the achievements toward social and economic integration: (1) they have established and maintained good relations with Government of Republic of Cameroon (GRC) officials; (2) they have involved village chiefs in decision making; (3) they have helped ensure that host villages benefit from external assistance; and (4) they have placed a high priority on agricultural and livelihood interventions. […]

Social integration has been somewhat natural because of the shared ethnicities and nomadic pastoralist culture, which occasioned seasonal migrations across the border for many years. Social integration has been facilitated by the GRC no-encampment policy, respect for refugees' rights to freedom of movement, and allowing refugees full access to public services, as well as the villages' goodwill, and the refugees' efforts to fit in" (US. Department of State, 2014).

4.5. The demographic dynamics resulting from refugee's inflow

The demographic dynamics is generated by two interdependent key structures:

(i) The refugee's inflow into the eastern Region and their flow paths between the three groups of population (From "Refugees arrived" to "Refugees in camps", from "Refugees arrived" to integration into "Local population", from "Refugees in camps" to integration into "Local arrived") increasing the "Local population".

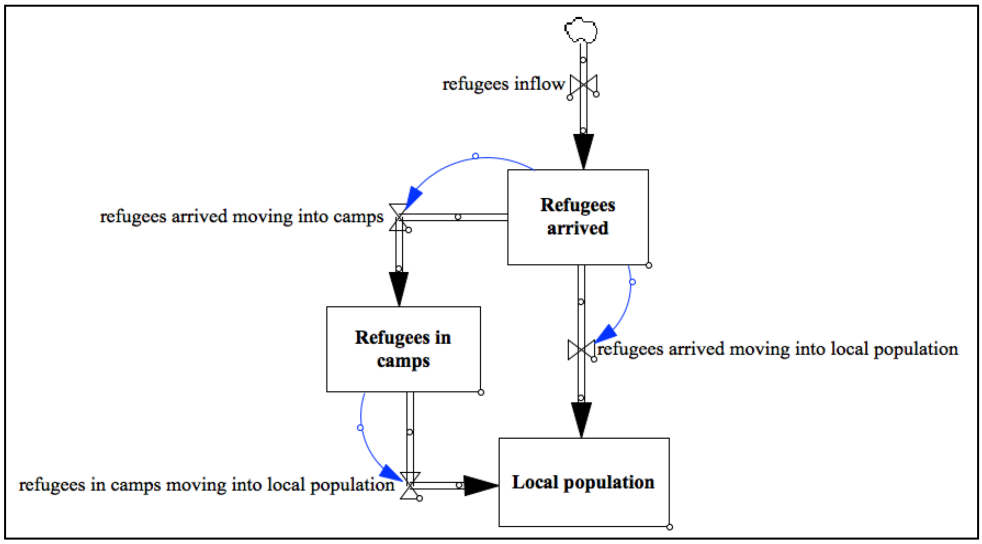


Figure 3. Refugees pathway to local population

(ii) The population model can be represented by an aging chain, in which the population represents a certain age range and cohorts (Sterman, 2000). The population and food dynamics for each of the three groups of population have the same structure inspired from the "Food & Population" structure in the world model (Forrester, 1971). Births and deaths in each group of population and in each cohort are linked to the food access and to the "crowding" in the eastern region of Cameroon.

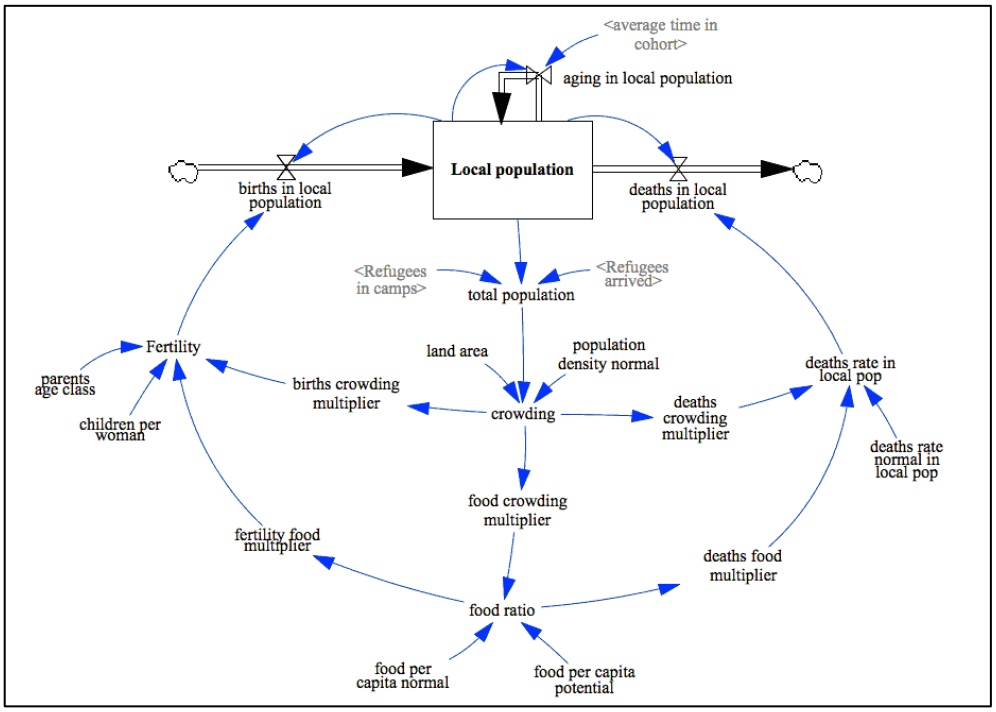


Figure 4. SFD of local population dynamics

4.6. Social indicators to be monitored over time

The eastern region is one of the poorest regions of Cameroon. The local social infrastructure such as education, healthcare, water, food, sanitation has a very limited capacity. Moreover, refugees from CAR hosted in the region have no full access of these social facilities. This contributes to overstretch the already poor capacity of the local social infrastructure.

Monitoring the key social indicators of the socio-demographic system over time helps the local authorities, policy makers and NGOs better assess and anticipate the impacts of refugees' inflow and also define more efficient and resilient policy response.

Our model allows highlighting the following social indicators:

- Drinking water access for the total population (encompassing refugees and local population)
- Ameliorated sanitation access for all
- Number of doctors per 10,000 inhabitants
- Number of nurses per 1,000 inhabitants
- People – Teacher Ratio (PTR): Average number of pupils (students) per teacher at a specific level of education in a given school year (UNESCO, 2009)

5. Simulation and Results

5.1. Time scale and time interval

In our model, we follow the monthly evolution of the social and demographic system of East Cameroon Region over 300 months, i.e. 25 years. The starting time in the model is the first month of year 2005 corresponding to the beginning of the first wave of refugee's inflow from CAR into Cameroon and particularly into the East Region.

5.2. Initial conditions

We assume that there are no refugees in the East Cameroon Region before 2005.

The size of local population of the East Cameroon Region in 2005 is 771,755 inhabitants (Cameroon's National Institute of Statistics, 2011).

5.3. Results

5.3.1. Refugees inflow increase significantly the size of East Cameroon population

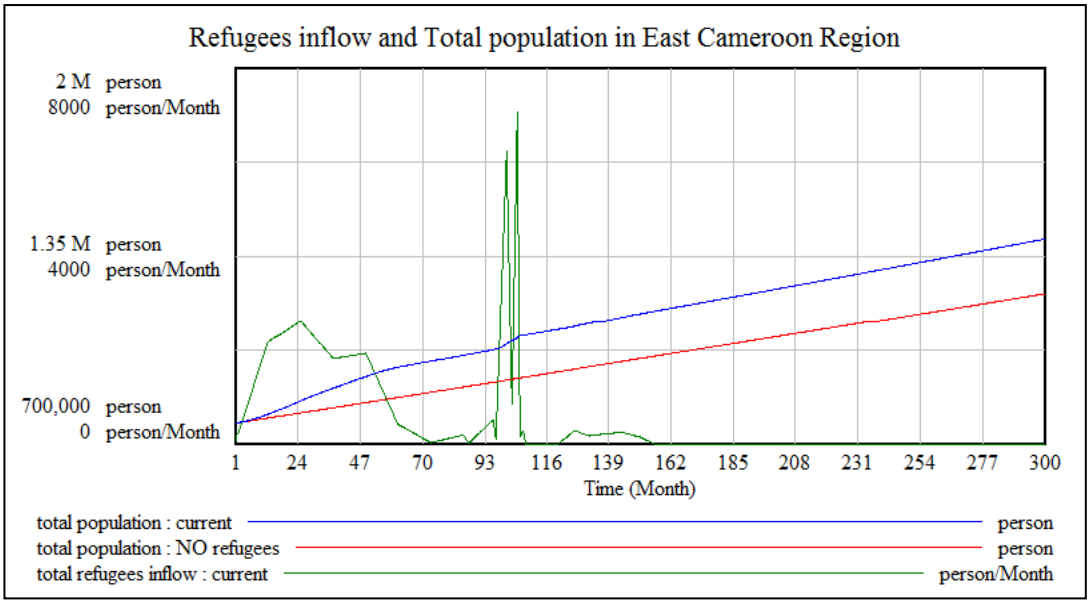


Figure 5. Refugees inflow and impact on total population

Refugee's inflow increases significantly the size of the population in the East Cameroon Region (blue curve in the figure) in two waves:

- The 1st wave of refugees between 2005 and 2007 (month 1 to month 52) causes by the civil war started in end 2004 and called "The Central African Republic Bush War" ("a civil war in the Central African Republic between Union of Democratic Forces for Unity (UFDR) rebels and CAR government forces" (Reuters, 2007).
- The 2nd wave of refugees between 2013 and 2014 (month 96 to month 107) caused by the deadly violence preceding and after the "Coup d'état" in March 2013.

This increase of population is sustained by:

(i) The population dynamic of each of the three groups: "Refugees arrived", "Refugees in camps", "Local population".

(ii) The conditions of transitions of refugees from arrived into camps and into the Local population.

The red curve in the figure shows the trend of the Local population of East Cameroon when there are no refugees.

5.3.2. Evolution of the populations of "Refugees arrived" and "Refugees in Camps"

Our model can illustrate the pressure generated by the refugee on the access to basic social infrastructure by the overall population of the East Region.

For illustration, compare the social indicator pressured by the addition of refugees population to the standards required by the United Nations Organisation.

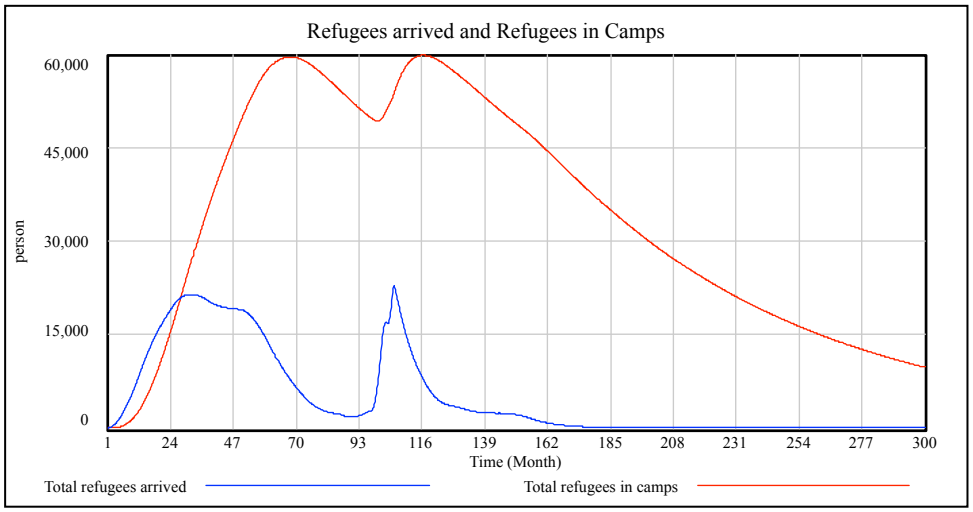
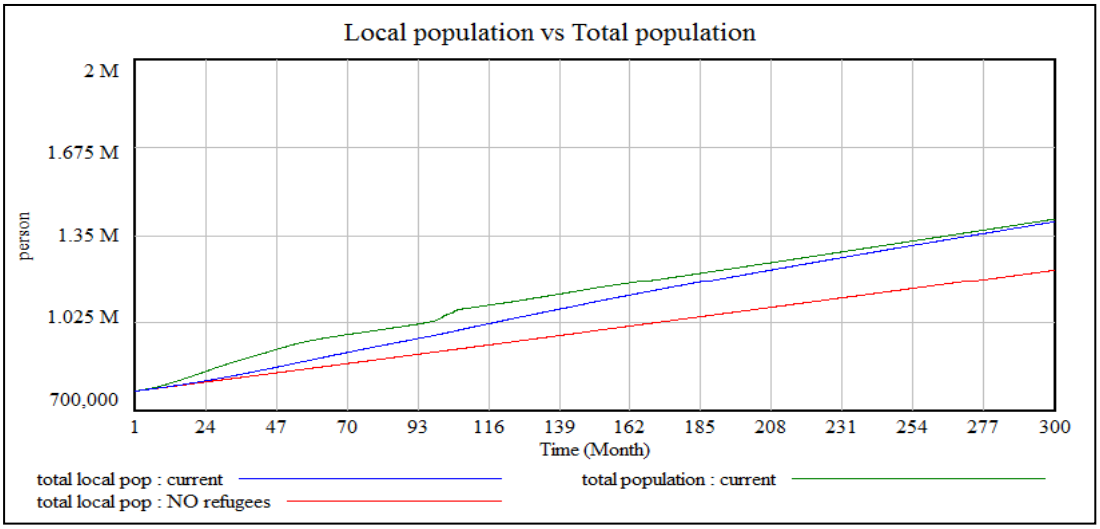


Figure 6. Evolution of Refugees arrived and Refugees in camps populations

The Dynamics of "Refugees arrived" follows the same trends as refugees' inflow. It shows us the size over time of the population in need of urgent assistance. The size of "Refugees arrived" population is regulated by the speed and size of transitions to camps and integration into local population.

The dynamic of "Refugees in camps" population has two peaks reflecting the two waves of refugees' inflow into the East Cameroon Region *(figure 6)*. The evolution of the "Refugees in camps" size is regulated by the speed and level of integration into local population. The decreasing trends in the total "Refugees in camps" red curve are explained by the policy of "Integration to local population applied" by the Cameroonian government and by the humanitarian organisations providing assistance in the region (cf. subsection ·). Integration population in this context is not necessarily leaving refugees camps, but is achieving self-reliance and being fully integrated into the social ecosystem of East Cameroon Region.
Nevertheless, integration of refugees into local population increases significantly the size of the "local population" and thus raising notable challenges in term of access to basic social infrastructures.

5.3.3. Evolution of the Local population compared to the overall population



7. Evolution of local population compared to the total population

Due to the policy Integration into "local population", the model shows that, if there is no more refugees' inflow, almost all refugees will be integrated in the local population at a certain point in time and exit the group of population in need of assistance from humanitarian organization. In contrast, the local collectivity of East Cameroon Region will have to address the challenges and opportunities generated by the sharp increase of the local population size.

The evolution of the difference between the sizes of total population and local population represents the evolution over time of the population in need of humanitarian assistance shown by the blue graph below.

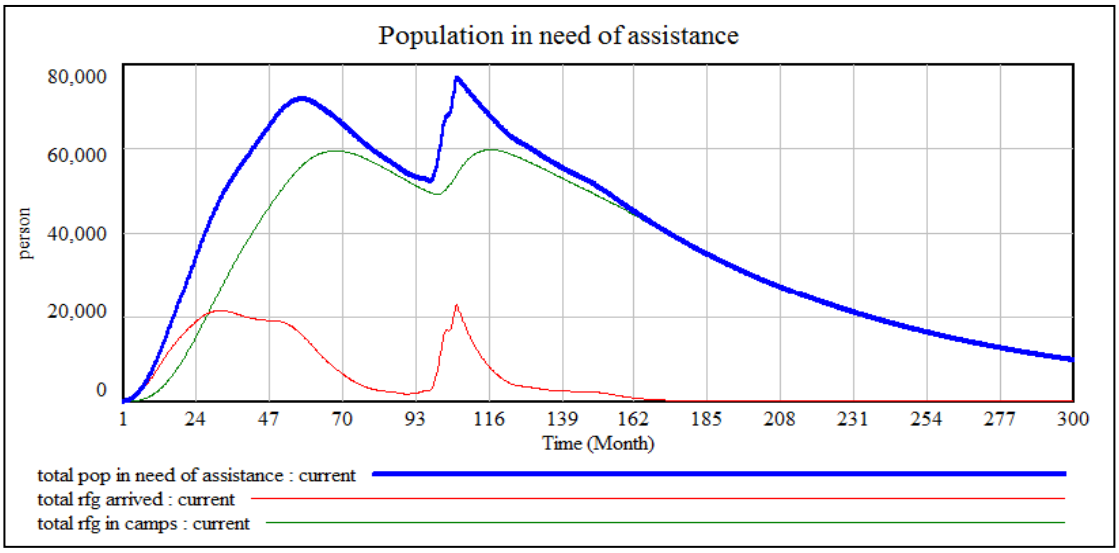


Figure 7. Evolution of the population in need of assistance

5.3.4. Impact of refugees on the social indicators in the East Cameroon region

The basic social infrastructure capacity is already very limited compared to the United Nation Standards. The refugees' inflow increases significantly the size of the overall population in the East Cameroon Region and reduces drastically the access rate to basic social infrastructure as illustrated in the following figures. Curves in red show the behaviour over time of the social indicators if there were no refugees in the region. While, the curve in blues show the same indicators but taking into account the refugees and the associated demographic dynamics.

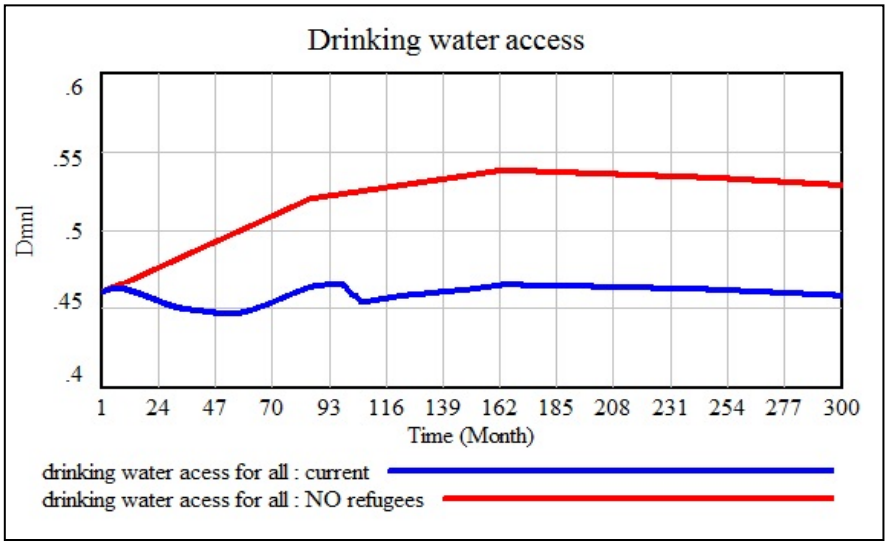


Figure 8. Impact on drinking water access ratio

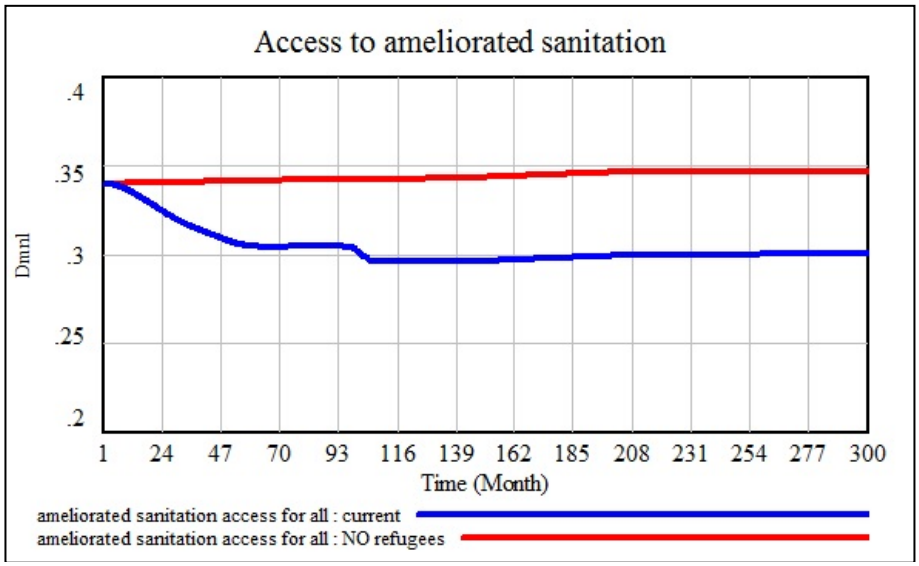


Figure 9. Impact on access to ameliorated sanitation

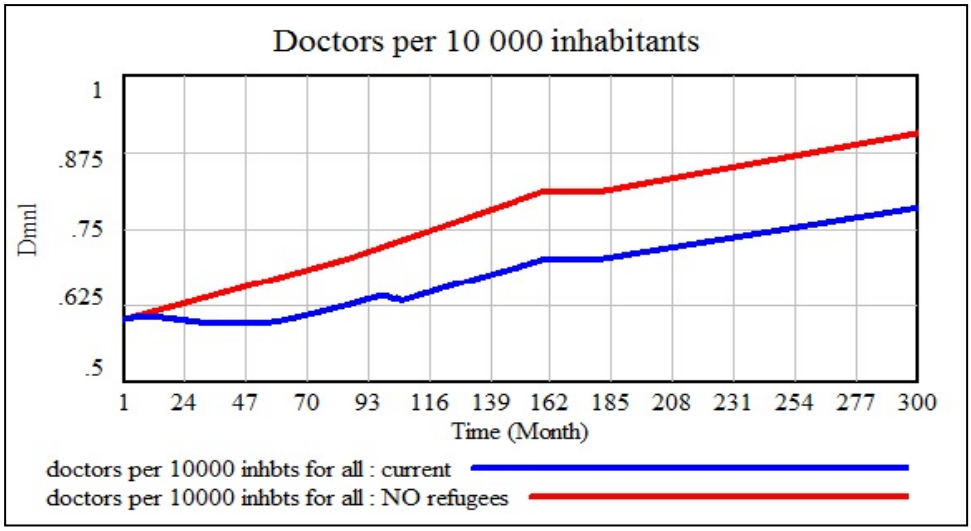


Figure 10. Impact on access to doctors

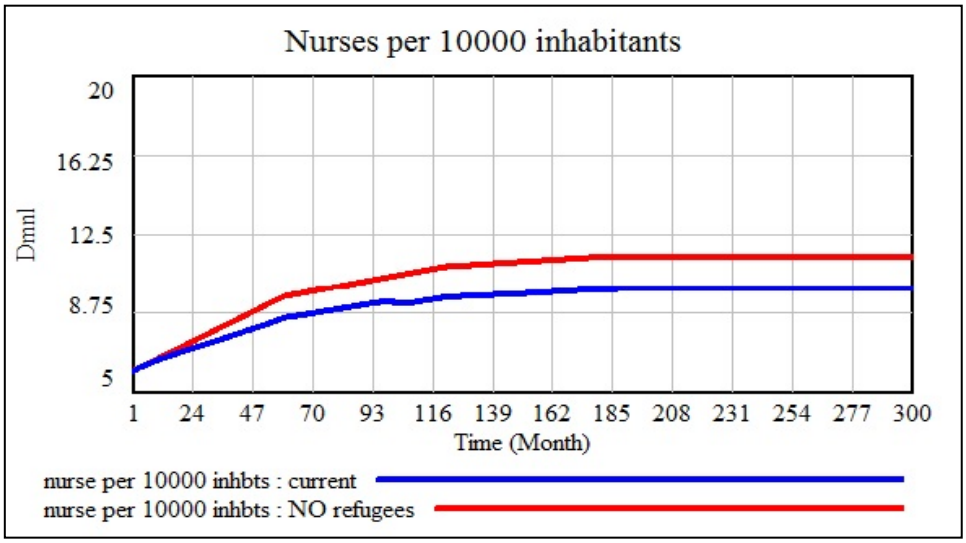


Figure 11. Impact on nurses coverage

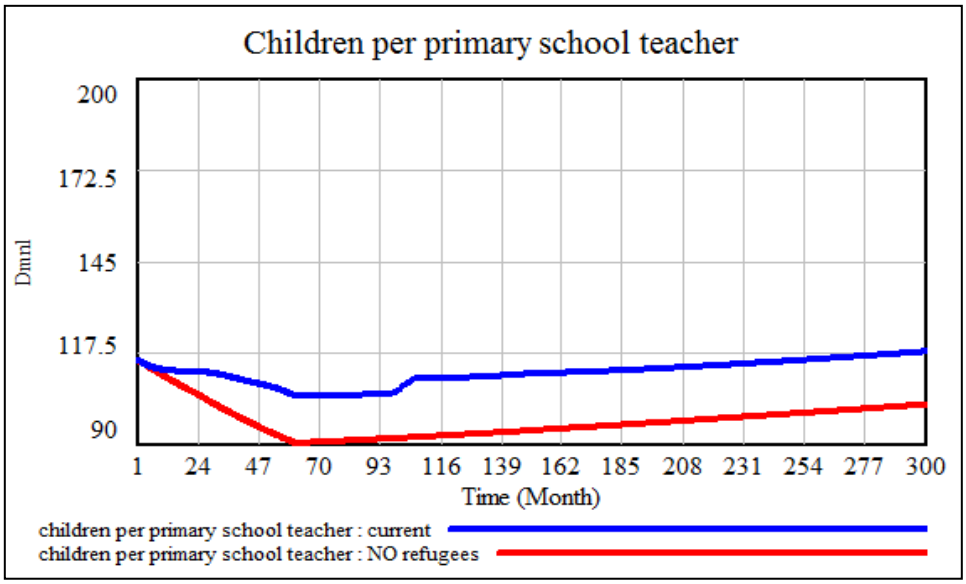


Figure 12. Impact on the children per teacher ratio in primary school

6. Conclusion

Using system dynamics approach allowed us to represent schematically our understanding the demographic system resulting from the CAR refugees inflow into East Cameroon Region. This representation is a powerful tool enabling all the stakeholders dealing with the refugees' issues to gain a holistic view of the demographic issues and the induced social consequences. Computer simulations of the model illustrate the evolution over time of the overall population, local population and refugees demography. It allows monitoring the evolution over time of the "Population in need of assistance".

The refugee's inflow from CAR raises significantly the size of overall population in the East Region of Cameroon. The evolution over time of the population in need of assistance is linked to the dynamics of integration process of refugees into the local population Moreover, The policy of integration of refugees into the local population, rises drastically the size of the local population in the medium and long term, leading to majors challenges (e.g., in terms of social infrastructure) and certainly opportunities too for the eastern region of Cameroon collectively. The basic social infrastructure capacity in East Cameroon Region is completely overstretched by the demographic impact of refugee's inflow from CAR.

The model shows the gaps in term of basic social infrastructure capacity and allows to: (i) dimension accordingly the humanitarian assistance in the short and medium term; (ii) Design an efficient governmental policy response to cope with the new level of the local population size in the long run. The model is also helpful to perform a broad range of scenario such as:

- Test the impact of a 3rd wave of refugees in the East Region
- Test the impact of the food access ratio on the overall population dynamics
- Test the effect of the speed and efficiency of integration of refugees into local population on the overall population and population in need of assistance dynamics
- etc.

This model is just a starting point regarding the refugees' issues impacts in the East Cameroon Region or in others Countries in the world. The next steps will be able to complement the model with economics, resource and food production components.

The model can also be used as a training tool to reinforce the capacity of local authority and policy makers in the management of Refugees issues or more generally in the management of social issues with complex system background.

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