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Research Article

WATER AND ENERGY MANAGEMENT IN CAMEROON: ISSUES CURRENT AND FUTURE SOLUTIONS

[1]Francine Merveille MAWAMBA and [2,]* Henri WAMBA

[1]PhD student at the Faculty of Sciences, Department of Physics, University of Douala-Cameroon.
[2]Professor at the University of Douala-Cameroon.

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ABSTRACT

This article illustrates the problems of water and energy management in Cameroon and the consequences on the level of poverty of the populations. At the same time, it highlights the possibilities of getting them out of this situation through various projects based on governance programs, in particular decentralized territorial community development and the contribution of teaching and research structures, such as the engineering schools, by taking these issues into account; the solutions envisaged will have to take into account the significant potential resources available to Cameroon, like most African countries.

Keywords: Water – Energy – Sustainable development – Poverty – Governance – Community development.

INTRODUCTION

The challenges and difficulties of access to water and energy in developing countries have long been and are the subject of several world summits. This difficulty of access to water and energy is accompanied by a shortage for some and for most by poor management of resources. Greater control of water and real energy efficiency represent one of the keys to local and sustainable development of communities in under developed countries.

In Cameroon, where there is significant hydraulic potential, the shortage of drinking water is the daily life of the populations with its dramatic consequences. Nearly 40% of the population does not have access to drinking water and one inhabitant in two suffers from waterborne diseases. The questionable water quality also preempts the development of agricultural yields that have remained essentially rainfed, while the survival of many families depends on them. How to explain such a significant water risk when Cameroon, with the exception of the semi-arid zone, does not lack water a priori? Cameroon has five major rivers in addition to very large groundwater tables. The demographic dynamics experienced by the country invites us to control water. In particular, it will be necessary In addition to the difficulties of access to drinking water, the majority of the Cameroonian population does not have access to basic energy services. Electricity remains a luxury for Cameroon that only a privileged few in large cities like Yaoundé or Douala can afford with relative constancy. The neighborhoods of some major cities in Cameroon are hit by network disruptions and frequent power cuts. In rural areas, what is commonly called load shedding can extend over several days (Moukengue Imano, 2015). The hydroelectric potential of the country is however, after that of the Democratic Republic of Congo, the best in Africa (Davoc 2008). One could therefore ask the question: How to use these energy resources to improve the standard of living of the populations and what role can Cameroonian teacher-researchers play in this situation? In this inventory, we will first raise some important issues such as the demographic factor, technical problems, human potential and technology transfer. Finally, we will propose some solutions to this crisis. We will thus discuss decentralized electrification and renewable energies. Finally, we will propose some solutions to this crisis. We will thus discuss decentralized electrification and renewable energies. Finally, we will propose some solutions to this crisis. We will thus discuss decentralized electrification and renewable energies.

***Corresponding Author: Henri WAMBA,**
2Professor at the University of Douala-Cameroon.

THE WATER SECTOR IN CAMEROON

General overview of water resources in Cameroon

- The precipitations
  Due to its elongation from south to north over approximately 1200 km, Cameroon is subject to two major climatic sets, equatorial and tropical. Precipitation decreases rapidly from the Atlantic coast of Mount Cameroon (8,000 mm at Debundscha) towards the borders of the country to the east (1,600 mm at Lomié) via Douala (4,000 mm) and Kribi (3,000 mm). They also decrease, but slowly, from the south (1600 mm at Yaoundé) towards Lake Chad (500 mm at Kousséri) passing through 1000 mm at Garoua. The average annual volume of precipitation over the whole country is estimated at 800 km3, unequally distributed between the south (600 km3, or 75%) and the north (200 km3, or 25%).

- Surface water resources
  Southern Cameroon is drained in its western part by numerous coastal rivers of unequal size, and in its eastern part by tributaries of the Congo River. As for the north of the country, it is drained by the Bénoué, a tributary of the Niger and the Logone, a tributary of Lake Chad. The evaluation of surface water resources based on the work of many researchers indicates values of 229 km3 for the south against 35.5 km3 for the north, ie a total of 265 km3 for the whole country.

- Groundwater resources
  Of the 322 billion cubic meters of total available water resources, groundwater constitutes 21% (57 billion cubic meters) of this resource (Sigha-Nkamdjou *et al.,* 2002). High rainfall means high recharge potential in much of Cameroon, except in the north. On the other hand, the groundwater potential is largely linked to the

types of rocks encountered in the territory. In the northern region, for example, the increase in population, combined with a reduction in the amount and regularity of rainfall, has led to persistent drought and a reduction in groundwater resources (Cheo *et al.,* 2013).

- Water availability per capita
  The estimation of water availability per inhabitant is approached at the national and regional scales (south and north). It is inversely proportional to population growth. Thus, in 2010 it went from 21,000 m3 to 15,000 m3 for the whole of Cameroon; from 23,000 m3 to 17,000 m3 for the south and from 15,000 m3 to 11,000 m3 for the north. With regard to the water stress threshold (1000 m3/h/year) and that of total water deficiency (500 m3/h/l/year) according to Khroda (1996), the situation would not seem worrying, and even for the next decades if the current average available remains stable and well managed. On the other hand, potential climate change and the future development of water-intensive activities such as agriculture through irrigation require good control and more rigorous management of resources.

Water management issues

Overall, despite the availability of water that is largely sufficient for the country, the drinking water needs of the populations show a significant deficit in both urban and rural areas (only 11% of the entire Cameroonian population have constant access to drinking water). This situation is due not only to the unequal spatial distribution of the resource, but also and above all to the problems linked to the socio-economic development of the country and the high cost of water in relation to the income of the populations. Overall, about 70% of the population consumes water of dubious quality. In summary, the problem of water in Cameroon is linked to several factors which are population growth, anthropogenic threats, climate change and finally losses during distribution.

- population growth
  In terms of demographics, the population of Cameroon in January 2010 is estimated at 19,406,100 inhabitants, 55% of whom live in urban areas and 45% in rural areas. It is experiencing galloping urbanization with a rate of 6% per year, while population growth is at 2.8%. This rapid urbanization of the population is hardly accompanied by the development of basic infrastructure to improve access to water.

- anthropogenic and/or natural threats
  Anthropogenic threats to waters in Cameroon are linked to pollution. The disposal of gray water to it is generally done directly on the public road, in a gutter, in a sump or in watercourses (Nlend *et al.,* 2018). Similarly, the water from the emptying of septic tanks is routed to the rivers of the basins, where they are discharged in disregard of the provisions relating to the protection of the environment and those relating to the protection of water resources contained in the law establishing the water in Cameroon (MINEE, 1998). Under these conditions, the environment is characterized by a state of generalized unhealthiness of the living environment. Most industries discharge their effluents into the watercourse without prior treatment.Some groundwaters contain low oxygen and high concentrations of iron and even hydrogen sulphate (Ketchemen-Tandia, 2011). Shallow coastal aquifers are vulnerable to seawater intrusion. Moreover, extensive bacteriological contamination of shallow groundwater in urban areas, such as Yaoundé and Douala (Kringel *et al.,* 2016) from household, industrial and hospital wastes has been proven by several authors. In Douala, studies have shown pollution by nitrates (Ngo Boum-Nkot *et al.,* 2015, Wirmvem *et al.,* 2017) and organic pollution (Sanou *et al.,* 2015) of groundwater.

Future solutions

Cameroon's hydrological gaps must be clearly identified and prioritized. It is important that a real synergy be established between the different water stakeholders; as well as a national network of hydroscience specialists. In addition, capacity building for all water management stakeholders must be strengthened. On a scientific level, researchers and teacher-researchers must work on the following investigations throughout the territory:

- Resilience of groundwater to climate change and sustainability of aquifer recharge mechanisms
- Functioning of basement aquifers and improvement of prospecting techniques

Basement aquifers represent 70 to 80% of the territory of Cameroon. Searching for groundwater is very difficult there and the drilling failure rate for these regions is very high. A hydrogeological methodology for identifying resources therefore remains to be proposed in order to limit this failure rate and to improve the quality of prospecting and reconnaissance from the design phase of supply projects.

- Issues of freshwater/marine water interfaces in coastal/estuarine areas
- Hydro-ecological study of coastal wetlands (maintenance of ecosystem services of mangroves and estuaries – human food, biodiversity, water regulation, etc.)

Cameroon in its coastal part is characterized by the presence of many large wetlands which provide a large number of ecosystem services to the populations (human food, maintenance of biodiversity, contribution to water regulation, etc.). However, these environments are increasingly impacted either by human activities and the anthropization of the coast, or by climatic disturbances which are the source of an increase in the sea level, and a great variability of the contribution in freshwater to estuaries (via groundwater and rivers).

- Implementation of a better policy for the implementation of protection perimeters around groundwater catchments for the production of drinking water

If texts exist in Cameroon on the regulatory aspects concerning this question, the documents on the satisfactory and generalized implementation of protection perimeters established and sized in a technically valid and scientifically correct way still seem to be lacking at the national level. A technical and legal effort therefore remains to be made in this direction and should constitute a priority because, as has appeared in numerous hydrogeological studies, underground pollution is often not very limited to the immediate vicinity of wells and boreholes because of the non-existence adequate protection perimeters.

- Problem of the contamination of surface and ground water by organic micro-pollutants and in particular agricultural pesticides.

Like all the countries of West Africa and Central Africa, Cameroon seeks to optimize its agricultural potential, this requires an increasingly important use of agrochemical molecules such as pesticides. This is done in an uncontrolled way with the use of molecules that are often regulated or even banned on other continents. The result is a fairly new problem for Cameroon, which is faced with a deterioration in the quality of water that is not only chemical and bacteriological but also increasingly organic due to the use of modern pesticides, herbicides and fungicides. .

- Support for the implementation of IWRM (Integrated Water Resources Management)

Three main axes can be carried out at this level:

I. Develop a favorable environment at the political level by setting objectives for the use, protection and conservation of water, then at the legislative level by passing the laws to be followed to apply the policies and achieve the objectives, and finally allocate financial resources to meet water needs;
II. Establish an institutional framework with a coordinating body for the formal and informal aspects of water management and human resource development;
III. Set up management instruments for the more efficient use of water. Manage disputes, guarantee water sharing taking into account efficiency and equity. Improve knowledge through training and communication.

THE ENERGY SECTOR IN CAMEROON

State of energy problems

The problem of the energy situation in Cameroon as well as the consequences on the level of poverty of the populations can be stated from the following factors:

- The demographic factor
  Since 1976, the annual growth rate has been 3% (Habitat III, 2015). At this rate, the country could have more than 30 million inhabitants in 2030. It is therefore necessary to study the adequacy between population growth and energy supply (electricity, gas, etc.). Today, the coverage rate barely reaches 50% of the national territory (Tchatat, 2014). The highest rates are concentrated in Yaoundé and Douala, where access is 98.2% and 97.1% respectively. The capitals of other regions are not better off, however. In Maroua, in the Far North, the rate of access to electricity is 11.8%. It is 16.6% in Garoua, in the North, and 25.5% in Ngaoundéré, in Adamaoua (Tchatat op cit.). With the current rate of population growth, if no investigation is made, the population without access to electricity will almost double in ten years for certain regions - particularly in the Far North and 'ls where the lack of infrastructure is cruel (Davoc, 2008; Tchatat, op cit.). Table 1 gives the proportion of households with access to electricity between 1991 and 2011.

Picture: Estimated proportion of households with access to electricity in 1991 – 2011 (Tchatat op cit.).

	Urban areas (%)	Rural areas (%)	Total (%)
1991	63	8.7	29
1998	79.1	22	40.7
2000	79	21	41.3
2005	81.9	21.8	42.8
2006	82.5	22	43.1
2007	83.1	22.1	43.4
2008	83.7	22.3	43.7
2009	84.3	22.4	44.1
2010	84.9	22.6	44.4
2011	85.6	22.8	44.7

- Lack of training
  In 2008, AES SONEL revealed the main problems it faces (Davoc op cit.): the insufficient quality of the IT tool for customer management, the insufficient quantity and quality of personnel and the mismatch between the profile of agents and the position they hold.

- Non-modern distribution networks
  Cameroon's energy deficit is not simply the result of insufficient production. It is also partly due to the multiple losses caused by the transport and distribution process. 6.5% of the energy produced in Cameroon would be lost in the transmission process, while 29% of this energy evaporates in the distribution circuits, due in particular to multifaceted fraud and the quality of the equipment (Investing in Cameroon, 2013). Moreover, according to Moukengue Imano (2015) these technical losses contribute to 40% of the amount of the bills of subscribers to the public network.

In the industrial sector, the technologies used are often outdated and cause significant energy losses. Associated with high energy production costs, this implies significant competitiveness problems for companies.

Some Solutions

Faced with the ills from which Cameroon's electricity sector suffers, one could ask the question: What can be done to promote the electrification of the country? Here we take up some proposals from Ngnikam (2006):

- Promote the development of new electricity production capacities, certainly favoring hydroelectricity by virtue of its potential, but while aiming for a diversity of production sources in a ratio of 25 to 30% thermal against 70 to 75% for hydraulics for example.
- Work towards the modernization and development of electrical energy transport and distribution networks.
- Implement measures to accelerate access to modern energy services, particularly in rural areas

It is entirely legitimate to think in particular of improving access to energy services in rural areas. It should be noted that in Cameroon, as in several southern countries, the rural population is still very high. A non-negligible proportion live in isolated villages or in scattered dwellings, thus making rural electrification by connection to the national grid very complex. Decentralized energy solutions are in this case preferred whenever connection to the national grid is considered very expensive. However, this development requires fairly advanced technological capabilities.

- Decentralized electrification: renewable energies
  When the distance from the rural site to the national grid is significant, decentralized electrification through renewable energies remains an ideal option. However, we will still come up against the problem of the transfer of technologies and knowledge to enable municipalities and local populations to appropriate the techniques.

The different renewable energies (apart from hydraulics) that can be used in the decentralized electrification process in Cameroon are:

- energy from biogas
  By fermentation out of oxygen, organic compounds (human and animal waste) produce methane called biogas (RECORD, 2009).

- wind energy
  The use of wind systems makes it possible to recover the energy linked to the movement of air masses. This recovered energy is a function of the wind speed and the surface of the blades (UNCC, 2015).

- photovoltaic solar energy, solar thermal,
  Through photovoltaic cells, the energy contained in solar radiation is converted into low voltage direct current (Slaoui, 2013). This solution can indeed be very well adapted in the regions of North Cameroon where temperatures sometimes approach 35°C in the shade (L'Hôte, 2005). This alternative allows a service close to the service provided by the conventional electrical network in terms of lighting quality. However, it requires more monitoring than a classic network installation. It also requires a larger storage system than current network systems. For example, these systems are quite widespread for lighting and audiovisual power in Kenya, Morocco and Zimbabwe (Davoc, 2008).

As for solar thermal energy, there are two main uses:

- Solar dryerswhich transform the heat into solar energy by interposing a dense and opaque material. The average yield is 4 to 6 kWh per square meter per day in clear weather.
- The solar water heateris characterized by a solar collector with or without storage of hot water and by the circulation of hot water. These systems are generally intended for urban environments.

Technology transfer

All the solutions that have been stated above would not be feasible if the problem of technology transfer were not resolved. Researchers must develop techniques to promote water management and energy efficiency. For sustainable local development, studies must be carried out to optimize water and energy management. Decentralization also allows local communities to better take ownership of the problems inherent in these factors and to find appropriate solutions, accompanied, for this, by technicians from training and research structures who have integrated water management issues. and energy in their programs. The research work must be done taking into account the definition of the needs and the potential impact on the communities. Students must be trained in technologies likely to meet the long-term needs of Cameroonian populations.

CONCLUSION

This synthesis highlights water and energy issues in Cameroon but also leads to improvement of the national hydrological/energy scheme. The water sector requires a legal and institutional reorganization, an improvement in the skills of all stakeholders and a dynamic monitoring of the resource in terms of quantity and quality. Given the qualitative degradation of the resource, due to urbanization on the one hand and agricultural activities on the other hand, consideration should be given to developing the water treatment sector. As for the energy sector, a sustainable response to the energy efficiency problem of local communities should be envisaged, which involves the development of concrete actions aimed at helping the government to design regulatory tools that eliminate energy waste and regulate the production or consumption sector. There is a need to diversify energy sources and accelerate the diffusion of efficient technologies, by creating a flexible technology transfer mechanism.
These measures, to be effective, must be backed by training and research structures making it possible to train technicians/experts and to anticipate problems for the purposes of harmonious and sustainable development, the result of mastery of management of water and energy problems, the main factors of human well-being in developing countries.

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