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Review

Municipal drinking water source protection in low income countries: Case of Buea municipality-Cameroon

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Source water contamination poses a risk to public health and increases the cost of drinking water treatment. Source water protection is a proactive approach for the enhancement of drinking water quality and quantity. A combination of research methods (desk review, interviews and reconnaissance field appraisal) have been used to identify major drinking water sources in Buea, land use activities which constitute potential threats and pathways of contamination of these sources as well as the capacity for source water protection in Buea. Our findings revealed that anthropogenic activities around the six major drinking water sources studied present visible potential threats and pathways for contamination, and that source water protection has not been given adequate attention in the planning and development of Buea. The potential human and social capacities are limited by the lack of financial and technical resources. This is further compounded by the fact that institutional arrangement does not facilitate the integration of land and water management at the local level. A framework for local strategic multi-stakeholder source water protection with the potential to foster leadership, pull together available resources from different stakeholders and reduce potential resistance to the integration of land and water management has been proposed. There is an urgent need for the adoption of a precautionary approach and research to develop baseline data that will enable comprehensive source water protection measures.

Key words: Source water protection, drinking water, water contamination, public health, stakeholders, buea, Cameroon.

INTRODUCTION

Source water contamination poses a risk to public health and increases the cost of drinking water treatment. Source water protection is a proactive approach for the enhancement of drinking water quality and quantity. In a 2005 report of the World Health Organisation (WHO) and United Nations Children Education Fund (UNICEF) titled - Water for Life: making it happen- it was revealed that the costs of installing water supply systems in sub-Saharan Africa are still far higher than is necessary (WHO/UNICEF, 2005). The report also notes that in global terms, the gains that have been made in improving access to improved drinking water have been less obvious due to threats posed by deteriorating water quality caused by among other things, the contamination of potable water sources. Based on this, assumptions on the initial safety of water sources are discouraged and recommendations made for the institutionalisation of adequate protection of drinking water sources. Policies related to source water protection, such as the multi-barrier approach recommended in the 2002 O'Connor report, amendments to the U.S. Safe Drinking Act to include state-level source water assessment and the 2000 European Union Water Framework Directive that mandates "good status" for water quality in major water suggest that there is increasing recognition of the fact that

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water quality and quantity threats can have significant impact on human health, the environment and the economy (Ivey et al., 2006). Episodes of source water contamination and the impacts on human health and social welfare abound worldwide (McQuigge, 2002; Hrudey et al., 2003 Olson, 2003). Perhaps the most outstanding is the case of the contamination of the public water supply, by E. Coli bacteria, in Walkerton Ontario, Canada which caused the death of seven people and made over 2300 people sick (O'Connor, 2002). Inadequate source water protection was noted as one of the contributing factors to the tragedy (Krewski et al., 2004).

Source water protection (SWP) is the first protective in a multi- barrier approach to water quality and quantity protection (Sylvester and Rodriguez 2008). A multi-barrier approach is an integrated system of procedures, processes and tools collectively aimed at preventing or minimising the public health risk of contamination of drinking water from the source to the tap. It is argued it is an effective way of managing public drinking water systems because prevention of contamination at the source enhances public health protection and is also more cost-efficient than the treatment of contaminated water.

Although access to safe and reliable sources of drinking water is a global challenge, it is particularly acute in developing countries (Ivey et al., 2006). This is the case in Buea municipality where the population has in the recent decade faced severe irregular, unreliable and intermittent drinking water supply characterised by water rationing with some localities going for weeks and months with dry taps. Inadequate source water flow and increased water demand due to unprecedented population growth and urbanisation have been blamed for the growing water supply crisis. Coping strategies include the use of untreated community water supply and exposed streams and springs as back-up and regular drinking water sources (Figures 1 and 2).

Inspired by this growing crisis of inadequate and unreliable water supply in Buea and the expressed concern of the local elected municipal authorities to seek short and long term solutions to the Buea water supply problem, the first author decided to explore this in his on-going doctoral research, titled "towards improving participatory multi-stakeholder water management, governance and decision-making in sub-Saharan Africa: Case of Buea-Cameroon. Given the uniqueness of factors in every environment (de Loe and Kreutzwiser, 2005; Ivey et al., 2006), and considering that both water quality and quantity are to a large extent dependent on the state of water sources, a necessary first step was to get a general overview of drinking water supply sources in Buea. The specific objectives of the study were:

(a) Identify and visually characterise, based on surrounding land use activities, the major drinking water supply sources in Buea.
(b) Evaluate the capacity for source water protection in Buea municipality.

Figure 1. Community water supply scheme (Koke).

Figure 2. Exposed drinking source (Bonduma).

(c) Suggest a framework for participatory multi-stakeholder source water protection at the local level.

The relevance of this study cannot be over-emphasised considering the public health risk of consuming untreated water – a growing situation in Buea, the need to raise awareness and to initiate precautionary actions on source water protection, especially among key actors, and the importance to contribute knowledge on source water protection issues in rapidly growing municipalities of low income countries. Furthermore, this study bridges the gap on and integrates drinking water source protection with among previous unpublished studies in the area on integrated watershed management (Folifac, 2003); rural livelihood and social infrastructure (Schmidt-Soltau, 2003); and the adequacy of Buea water supply network (Buea council, 2005).

The rest of this paper is structured as follows: brief definition of key words in source water protection literature, description of the study area, research design and methods, results and discussions, proposed framework for sustainable source water management and conclusions.

BRIEF DEFINITION OF KEY WORDS IN SOURCE WATER PROTECTION LITERATURE

In this section, a brief definition is provided for some key words that are frequently used in the growing literature on source water protection (see for example: Trax, (1999); Lin et al. (2000); Herrick (2001); De Loe et al. (2002); Gullstrand et al. (2003); Almasri and kaluarachchi (2004); Krewski et al. (2004); Ivey et al. (2006); Trimmer et al. (2007); Sylvestre and Rodriguez (2008)) and as used in this paper.

Water source: This is the type of water body (such as springs, lakes, streams, aquifers or wells) used for drinking water supply.

Source water: The "raw" or untreated water from a water source.

Source water protection/management: This includes legislation/policies and site specific actions, based on the level of risk, to reduce risks of contamination, depletion and to enhance source water quality and quantity. The objective of source water protection is to preserve or enhance source ("raw") water quality and quantity within water bodies that currently supply drinking water or are likely to be future sources.

Source water risk assessment: In simple terms it is the evaluation of source water vulnerability to and potential risk of contamination. This includes risk identification, assessment and management. There is a risk of source water contamination when both THREATS (human activities and natural conditions with contamination potentials) and PATHWAYS (routes through which contaminants can be transported from their point of origin to a receptor such as water body) exist, and depending on the magnitude of threats, pathways, population exposed etc, risk can be classified as significant, moderate, low or negligible (Gross and Richards, 2008). The risk management concept for each class include: mandatory and immediate actions to substantially reduce the risk for significant risks. Actions to freeze the risk at the current level as well as initiate plans to reduce the risk as opportunities arises in the case of moderate risks. Mandatory risk surveillance which involves monitoring the risk and the establishment of plans to prevent an increase in the risk for low risks, and no action in the case of negligible risks.

CONTEMPORARY BUEA MUNICIPALITY: AN OVERVIEW

Buea is the capital of the South West Province of Cameroon, with a population of about 200.000 inhabitants. It is located at the foot of Mount Cameroon (an active volcano 4010 m) at an elevation of 1000 m above sea level with a surface area of 870 km² (Buea Council, 2008). The urban area includes: Miles 14, 15, 16 and 17, Bomaka, Muea, Molyko, Bonduma, Great Soppo, Clerk's and Federal Quarters, Buea town, GRA, Likoko-Membea, and Bokwaongo. Daily temperatures range from 20 - 28°C annually. The municipality is characterised by a hilly topography, a dense network of springs and streams, high humidity and fertile volcanic soils. Buea experiences two distinct seasons: a rainy season that begins in April and ends in October - with a high annual rainfall between 3000 - 5000 mm, and a dry season that begins in November and ends in March.

The local government is the municipal council, known as the Buea Council, headed by a Mayor. The councillors and the Mayor are democratically elected every five years across political party lines. The Mayor is an auxiliary of the central Government. The Buea Council carries out projects aim at modernising the municipality and improving the delivery of basic services to its population (Buea Council, 2008).

The municipality is the seat of many private and public educational institutions such as daycares, elementary schools, secondary and high schools, vocational and professional schools such as Pan African Institute for Development West Africa (PAID-WA), Local Government Training Center (CEFAM), Cameroon Opportunities Industrialisation Center (COIC), as well as the University of Buea established in 1993. Buea is very accessible by road and has a relatively good road network and number of clinics and health facilities (Schmidt-Soltau, 2003). It is estimated that since the establishment of the lone Anglo-Saxon University of Buea, the municipality has continued to experience a very high rate of population growth and urbanization. According to the municipal council, on average at least 7000 people relocate to Buea each year. It also has several religious institutions, crown corporations such as the South West. Development Authority, Rumphi Participatory Projects, civil society organisations, and international institutions such as the German Technical Co-operation (GTZ) and Alliance Franco- Camerounaise (AFC).

The economy of Buea has been described as moderate with agricultural, administrative, business, tourism and the financial sectors taking the central stage (Buea, 2008). Although the municipality can be described as a service-oriented municipality due to its educational and administrative nature, several families depend on rain-fed Agriculture as a source of livelihood due to the rich volcanic soil, equatorial climate, high humidity and rainfall. In addition, two locally based agro-industrial companies the Cameroon Tea Estate (CTE) and Cameroon Development Corporation (CDC), are located in the municipality and own plantations for the commercial production of tea and bananas respectively.

In terms of water supply, Buea municipality has two principal water service providers: Camerounaise Des Eaux (CDE) and Community Water Schemes. Those not served by either of these providers rely on natural springs/streams or water from the agro-industrial companies above. Many households served by CDE and

Table 1. Indicator questions and criteria used to evaluate Buea municipality capacity for source water protection.

Criterion	Indicator question
Knowledge	What is the state of knowledge about source waters and threats to source water quality? To what extent, and how, do institutional arrangements contribute to development of local source protection knowledge?
Social and political support	To what extent do municipal and senior governments demonstrate political support for source water protection? To what extent do municipal residents demonstrate social support for source water protection, and how have they been involved in selection and development of source protection tools?
Legal authority	How is source water quality protected from the impacts of human activities and future land use activities? What mechanisms exist for targeting protection of sensitive water supply areas (e.g., catchments, recharge areas, riparian zones) and water supply areas physically located within the municipality's jurisdiction?
Integration	To what extent, and how, do institutional arrangements for land and water management encourage integration of development and water supply concerns? To what extent, and how, do institutional arrangements support the practice of source water protection at a watershed or regional groundwater scale?
Resources	Are sufficient leadership, financial, human, and technical resources available to conduct source protection planning and implementation?

Community schemes also rely on natural springs as backup during prolonged periods of water shortage. CDE is a private company (in a public private partnership paradigm recently adopted by the Government of Cameroon) responsible for the abstraction, treatment, storage, distribution of water, as well as billing and collection of water service charges. All its customers are metered and billed once a month. Community water supply schemes are generally self-reliant projects for specific communities. Unlike CDE customers, users of community water schemes are not metered and do not pay a monthly fee.

RESEARCH APPROACH AND DESIGN

Primary and secondary data sources were used to accomplish the objectives of this research. Specifically this involved a review of related documentation, field appraisal and semi-structured interviews with key actors. Document review and interviews with officials of the council and CDE were used in the identification of the major drinking water sources, while reconnaissance field appraisal and interviews were used for the visual characterisation of the state of these drinking water sources. The municipal capacity for source water protection was evaluated using semi-structured interviews. Drawing from the potential and usefulness of "indicator questions" in related and other studies, (McGuire et al., 1994; Merrey et al., 1995; United State EPA, 1998; de Loe et al., 2002; Ivey et al., 2002; Ivey et al., 2006; Trimmer et al., 2007; Sylvestre and Rodriguez, 2008) evaluation criteria and "indicator questions" were developed and used (Tables 1 and 2) as leading questions/indicators to ensure detailed narratives rather than a simple "yes/no" answers during interviews to explore the municipality capacity for source water protection.

Table 3 shows the six water sources selected, for this study, on the basis of two criteria: current drinking water source, and serving a population of at least 2500. The identification of potential threats and pathways of contamination of each water source, based on observed anthropogenic activities was accomplished during a visit to each water source by a research team made up of the first author and three research assistants recruited and trained for this study. This was complimented with semi-structured interviews, by the first author, with any land or property owner met around the catchments. Twenty interviews were conducted involving a wide range of key actors such as senior officials at the council, CDE, Rumpi, community water management committees, NGO's

Table 2. Municipal resource indicators for source water protection adapted from Ivey et al., 2006

Resource components	Resource indicators
Financial resources	Funding is available for municipal source water protection projects from the municipal council or CDE.
	Funding can be obtained from other sources for protecting source water quality.
	Financial mechanisms are used as incentives for source water protection.
Human resources	There is/are dedicated institutions and/or employees responsible for protecting source water supplies in the municipality.
	There is availability of and accessibility to individuals with the necessary skills and expertise needed for protecting source water supplies.
	Education and training opportunities for source water protection are available to interested individuals and institutions.
Institutional	Legislation and policies provides for drinking water protection at the local level.
	Municipal plans, strategies and actions protect current drinking water sources and recharge areas through the control of land use activities.
	Land has been purchased for the protection of current municipal water supplies.
Social	Clear leadership for water quality protection at the watershed level exists.
	There is a functional collaboration and networking among the municipality, public institutions, civil society organisations and communities.
	Community awareness and support for source water protection has been developed to avoid conflicts with other activities such as agriculture and construction.
Technical	Municipal drinking water standards exist and the drinking water quality is monitored.
	Data needed to manage water supplies, delineate source water protection area and develop source protection plans are available.
	Municipal source water areas are delineated in official plans
	Municipal water recharge areas have been identified and potential water supply contaminant sources (point and non-point) have been identified.

Table 3. Potable water sources, exploiting institutions and population served.

Catchment	Exploiting institutions	Approximate population served*
German Spring	CDE	20000
Mosel Spring	CDE	50000
Koke	Community	4300 + CDC plantations
Small Soppo	Community	3000 + CDC plantations
Butiking	Community	10000
Bulu Blind	Community	10000

*Source: Buea Council (2005) and confirmed by other municipal authorities

Table 4. Observed activities in the vicinity of individual water sources.

Observed activities	Water source					
	German Spring	Mosel Spring	Small Soppo	Koke	Butiking	Bulu Blind
Animals	√	√	√	√	√	√
Poor vegetation cover	√	√		√		
Farming		√		√	√	√
Bush fire		√		√		
Waste disposal		√				√
Construction/toilets		√			√	

Figure 3. Level of source water protection (Small Soppo).

Figure 4. Level of source water protection (Koke water).

the media and land/property owners around the water sources. Notes were taken during the interviews which were also digitally recorded for further consultation.

RESULTS AND DISCUSSIONS

The observed anthropogenic characteristics of the individual sources are shown in Table 4, while the traditional level of source water protection is shown by Figures 3 and 4.

Observed activities around the water sources and possible implications

The propensity for source water contamination depends on several factors: soil characteristics, topography, vegetation, distance of septic tanks and other land use activities to the water source. Humans, animals and precipitation (runoff) are principal agents (mechanisms) of contaminant transport to water bodies. Constructed (paved) surfaces and bare soil increase the rate of overland flow (runoff) and provide conduits between contaminants and water bodies (Davis et al., 2004). Poorly positioned or improperly functioning on-site septic tanks have been linked to many outbreaks of waterborne diseases (Day, 2004). Subsurface soil permeability or soil subject to inundation and steeply sloping sites enhance the likelyhood of the presence of open pathways for contaminant transport (Goss and Richards 2008). Vegetated buffer strips have been found to increase surface runoff infiltration into the soil as well as the efficiency of contaminants removal from surface runoff (Goss and Richards, 2008). There is a clear risk of contamination of water bodies with direct animal access and a higher probability of the pathogens to travel further downstream from the point of release. The direct deposition of faeces into the water body increases the survival rate of pathogens due to rapid sorption of contaminants onto bed sediments (Goss and Richards, 2008). Joel and Karns (2000) observed that animal manure and faeces are key important sources of faecal contamination of water sources.

Bush fire and poor vegetation cover: Bush fire destroys vegetation, leaves the soil bare, loose and susceptible to erosion. The relatively high rainfall coupled with the hilly topography around the sources enhances the probability of soil erosion and therefore the transport of agricultural nutrients, sediments and other contaminants to the water sources thereby reducing both water quality and quantity. In addition, the destruction of vegetation exposes soil and water bodies to direct sun radiation which accelerates the rate of evaporation. This is likely to aggravate soil erosion and the rate of source water quality degradation due to an increase in contaminants concentration. Interviews revealed that uncontrolled

bush fires are common in the dry season when farmers prepare the fields for cultivation. That this occurs in the dry season when temperatures are usually very high (28 - 30°C) and the water supply crisis very critical suggest a great cause for concern.

While the poor vegetation cover observed at Mosel and Koke catchments were attributed to uncontrolled bush fire, that at the German spring catchment was attributed to deforestation practices and the cutting down of surrounding tress for firewood.

Housing and waste dumps: Only the Mosel catchment was observed to be located in a residential area with significant paved areas, presence of septic tanks and pit latrines. Solid waste dumps were also observed upstream of some water sources as shown in Table 4. While the solid waste dumps observed at the Mosel catchment could be attributed to its proximity to residential area that at Bulu Blind is likely due to biodegradable household waste for use as organic manure. Waste disposal in the proximity or upstream to water sources poses a threat to contamination because of leaching.

Farming and animals: As shown in Table 4, intense cultivation was observed in four cases. Apart from the Bitiking source where permanent crops such as cocoa were planted, interviews revealed that only seasonal crops such as tomatoes, pepper, maize, plantains and other vegetables were cultivated in around the rest of the catchments. Interviews revealed uncontrolled application of agricultural inputs such as fertilizers and pesticides. These are potential threats to source water quality given the seemly high water table in Buea and potential for surface runoffs and sediment transport.

Even though the team did not observe animals at all the sources during the field appraisal part of the study, especially at the Small Soppo, German spring and Mosel sources, interviews revealed that these were not uncommon.

Despite the presence of these potential threats and mechanisms for enhanced pathways, Interviews revealed that there is no history of source water contamination in Buea and public health concern due to source water contamination. However, given the rate of population growth and urbanisation, current land use practices and the topography of Buea, there is a high propensity of future source water contamination if protective measures are not taken.

Local capacity for source water protection in Buea

Institutional capacity: The indicators for institutional capacity used in this research are shown in Table 1. The 1998 laying lay down regulations governing the management of water resources in Cameroon and the 2001 decree of application relating to source water protection provides for protected areas around water sources and declares such areas to be of public interest. Some of the key relevant provisions to this study are:

1. Section 4(1) prohibits discharge, spray, infiltration, encroachment or dumping of pollutants of any nature into water bodies.
2. Section 6(3) forbids washing and servicing of motor vehicles, internal combustion and similar engine closed to water points.
3. Section 7 establishes water sensitive areas, such as wetlands and recharge zones, and protective areas around drinking water-catchments, water treatment and storage points. These protective areas are considered as land of public interest.

The final provision provides for the creation of water boards and special funds to promote best practices in water resources management.

Neither the law nor it decree of application define the perimeter for the protective area. The decree of application of the 1998 law entrusts the legal authority of source water protection to the ministry of energy and water. Considering that water quality is strongly influenced by land use activities within a watershed (Herrick, 2001) and that local councils are responsible for building (development) permits, the case is made in this paper that existing institutional arrangements do not enhance the integration of land and water management. This is probably reason for the big gap between the law and the practice. There was no evidence of an inventory of potential source water contamination activities and plans/ strategies such as by-laws and zoning plans that demarcation protective area around water sources to combat any emergencies.

Field appraisal and interviews revealed that in practice the land surrounding the water sources is not of public interest. There was no demarcation of protective areas or land that has been purchased as a protective measure to drinking water source protection. In addition, the current provision to declare the land that belongs to individuals to be of public interest was considered confrontational as well as a command and control approach by over 95% of the respondents. All the respondents envisaged possible resistance, especially from farmers if this law were to be implemented.

The counter-productive nature of the current institutional arrangement and political interference for the integrated management of land and water was illustrated using the case of a church which is said to be constructed at a sensitive water recharge point. According to a senior official at the local council, “the council did not approval the development permit of that church but because some top government officials in Buea worship there, we were instructed from above to approve the permit, since the construction, the water yield at the source has reduced considerably” the source further observed that “it is difficult and challenging to assume responsibility without the legal authority and powers”.

All the community water management committee officials interviewed did not consider source water protection as part of their responsibility. They observed that all the officials of the community water management committees interviewed noted that source water protection would be a difficult task for them to execute, given that they lack the necessary resources and powers especially as the land around the catchments are owned by individuals and serve as a source of livelihood for their families. One committee head observed thus; "Our role is limited to the repairs and replacement of damaged parts, cleaning of the storage tank and collecting a token from the community to accomplish these tasks... for us to be able to do that job, the government will need to formally recognise us (water management committee) as an institution and provide training for us to be able to develop local policies as well as provide us with money that can be used to purchase the land around the catchments thereby providing alternative source of livelihood for these people and giving us power over the land"

These findings suggest that the institutional capacity for local source water protection in Buea is very limited.

Financial capacity: According to an official of the council, there are two principal sources of revenue for the council: Government subsidies and service charges. Interviews suggest that the revenue generated from these sources is not sufficient to meet urgent economic development activities and provide other social services of priority. However, an official of the Rumpi Project, an African Development Bank funded project, revealed that source water protection is an integral part of their ongoing community water supply projects. The official observed that in order to avoid resistance from land owners and conflict with other land use activities especially agriculture, land surrounding water sources will be purchased and demarcated.

The lack of strategic local partnerships, a comprehensive source water protection plan and the absence of institutions dedicated to watershed and source water protection were also noted as limiting factors to the potential to access external finances. A senior official at the regional delegation of energy and water observed that when it comes to water supply projects, councils do not seem to have taken adequate advantage of the national council support funds, commonly known as FEICOM, which provide revolving funds for several council projects. Both CDE and community water supply committee officials noted that their charges for water supply services do not provide incentives for source water protection. They observed that following the general socio-economic atmosphere, any attempt to introduce financial incentives for source water protection needs to be carefully considered.

Based on these findings, it can be argued that there is an unexploited potential to locally finance source water protection initiatives. This seemed to be constrained by fragmented interests and lack of a dedicated source water protection institution.

Human capacity: Knowledge about source water protection as indicated by the presence of individuals with suitable training, access to necessary training opportunities and education materials are some examples of indicators for human capacity. In addition to being available, our study argues that for these resources to constitute human capacity, they should be readily accessible.

Interviews revealed that there are individuals, especially lecturers at the University of Buea, with the required knowledge and skills essential for source water protection. In addition, individuals with relevant academic and professional interest to source water protection were also identified in other institutions such as Rumpi and other common initiative groups. Despite this human capacity potential, interviews revealed that accessibility is a major challenge due to the lack of coordinated efforts and dichotomy between the key stakeholders. A lecturer at the University of Buea noted that:

> "Despite the goodwill to volunteer and the capacity to conduct research, we are limited by funding and the politics of the time, those who have funding for community projects do not seem to give research the importance it deserves and when they do, they prefer to bring expensive consultants from outside"

Over 85% of those interviewed did not know how and where to source materials and information on source water protection. More than 60% observed that the available human capacity was not productive and challenged them to organise radio programs and public information events such as seminars and workshops to sensitize and educate the public.

An NGO official observed that;

> "given the low level of awareness and inadequate priority given to source water protection, there is the urgent need for institutions such as the university of Buea, Local Government Training Centre (CEFAM), and Pan African Institute for Development- West Africa, all in Buea to institutionalise source water management through the organisation of short courses, because let alone to seek such opportunities, communities will not"

In summary, there is an uncoordinated pool of human capacity and opportunities which could be exploited for source water protection at the local level.

Social capacity: Leach and Pelkey (2001) noted that critical elements of social capacity are leadership, partnership and communication. Social capacity is enhanced when leaders can facilitate the coordination of stakeholders, provide vision and direction, initiate and maintain active linkages among stakeholders (de Loe et al., 2002); when citizens are involved in decision-making and implementation of management plans (NRC, 2000) and when

local authorities and institutions maintain communication with each other, with communities and with top levels of government (Durley et al., 2003). The later also observed that the active involvement of community members as well as education and communication to build awareness is an effective and efficient way to reduce local resistance to activities.

Our findings revealed that apart from the limited activeties of COWADAC to foster platforms for multi-stakeholder dialogue and public awareness, and the recent interest of council officials, there is no clear leadership for source water protection in Buea. Interviews revealed that several institutions and individuals have concerns about for source water protection. However, no evidence of coordination and common direction was identified. These suggest fragmented interests and activities. No platforms (formal or informal) for stakeholders engagement were evident from our findings. However, the Council and Rumpi seemed ready to take up the challenge of fostering platforms for citizens' engagement in source water management in order to increase awareness and also reduce the chances of any community resistance as well as increase the sustainability of projects.

Interviews revealed that linkages such as communication and interaction between institutions, communities and top level government officials were very minimal. An official from the state regional media noted that the local institutions are not making proactive use of the available local communication opportunities. The official challenged the powers that be to make use of radio and TV programs that have wide audiences (such as global voices for women) to reach the public with essential information. Proxy communication through churches, women groups, bill boards and posters were identified as possible means of reaching out to the public.

Technical capacity: Some indicators of technical capacity in source water protection and watershed literature (Robbins et al., 1991; Trax, 1999; Herrick, 2001; Focazio et al., 2002; Ffolliol et al., 2002; Trimmer et al., 2007) include:

- Reliable data such as water quality, hydraulic gradients and geochemistry of the watershed.
- Source water monitoring programs to provide baseline data, tract protection efforts and provide early warning of potential contamination events.
- Delineation of protective areas for source water protection.
- Drinking water quality standards.

Although there is potential human and social capacity for source water protection, our findings revealed that technical capacity was non-existent. This could be attributed to inadequate institutional arrangement, lack of adequate finances and collaboration as well as lack of a data management policy.

While the above are essential for a comprehensive source water management approach, it is important that a precautionary approach be initiated to pre-empt source water vulnerability.

Proposed framework for sustainable source water management

Acknowledging that source water management is a shared responsibility, the best way forward will be to implement a coordinated, integrated and interdisciplinary participatory stakeholder approach. This requires that an enforced and effective mechanism be put in place for true community involvement in planning, decision-making and monitoring (Harvey and Reed, 2007). Engineering solutions should also recognise the importance of effective stakeholder participation (Poolman and Van De Giesen, 2006). The current practise of building water supply systems for communities without adequately understanding their needs and including source water protection is counter-productive for water system sustainability (IRC, 1997).

Considering the current capacity for source water protection, in particular, the opportunities presented by the political commitment of the Lord Mayor of Buea municipality, the financial capacity of Rumpi, the presence of researchers at the university of Buea, and the institutional constraints, the most appropriate approach for developing sustainable source water management in Buea will be a local approach which pulls together the existing local resources (Ong'Or and Long-Cang, 2007).

Following the keen interest demonstrated by the council during this study, and the fact that over 80% of the interviewed considered the council as an institution that is or (should be) responsible for source water protection, it is suggested that the council should take leadership in source water protection, initiate horizontal network with the community, civil society organisations and other professionals such as from the media, agriculture and rural development, and water supply service providers. Source water protection could be discussed and planned in a holistic manner within city planning and zoning, that is, a shift from the traditional sectoral focus and quick- fix solutions, to a strategic and adaptive approach involving different stakeholders. If done within a participatory and strategic integrated development planning framework many issues, challenges, and solution strategies are likely to be identified and applied in a manner that will greatly minimize conflicts and provide far reaching benefits. Some issues that need to be addressed in a comprehensive and clear manner include:

1) Procedure for ensuring a multi-stakeholder team (representative participation).
2) Role of the various stakeholders.
3) Funding opportunities.
4) Mechanisms for communication and consultations.
5) Capacity building and training.

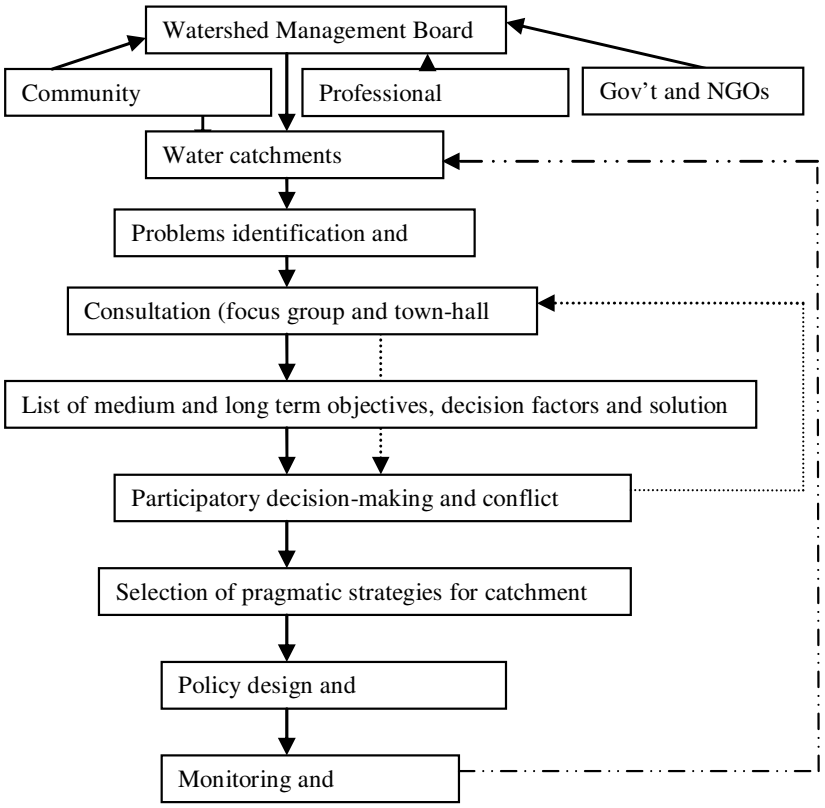

Figure 5. Proposed framework for sustainable source water management in Buea.

6) Mechanisms for conflict resolution

A proposed framework for participatory water source management within a watershed perspective is shown Figure 5. To improve on responsiveness and accountability, it is suggested that the watershed management board is institutionalised within the council structure of committees. Its chair could be elected to work in close collaboration with the Mayor.

Some of the key potential advantages of the proposed framework are as follows:

1. Provides clear leadership for, and institutionalisation of, participatory source water protection at the local level.
2. Promotes learning-by-doing, coordinated actions and integrated watershed management.
3. Initiates a platform for multi-stakeholder dialogue, networking and social learning essential for building trust needed for voluntary actions.
4. Increases the propensity to access the available pool of social, human and financial resources as well as access to external resource.
5. Facilitates the establishment of technical capacity considering that the council or local watershed board office would be a one-stop storage for and access to reliable data.

Conclusion

This study has evaluated the state of six drinking water supply sources in Buea and the capacity for source water protection using document review, interviews and a field study approach.

Our findings revealed land use activities indicate the presence of potential threats and pathways for source water contamination for the six water supply sources studied, notably agricultural sources, urbanisation and waste disposal.

Buea presents an example of a situation where available resources for source water protection have not been adequately exploited. The municipality potential for source water protection is characterised by the availability of human and social resources. Local financial resources though available do not seem to have been adequately resourced. There is also the potential for political commitment and leadership, as demonstrated during this study and revealed by key information, by the Lord Mayor of the council, elected across political lines. However, the municipality is still struggling with funding, amidst gaps in institutional arrangements and legal authority to initiate platforms for a collegial approach in source water protection. In addition, the municipality faces several constraints such as lack of technica

resources, political inference and, balancing economic and social development versus environmental issues such as source water protection. Its current authority to issue building permits could be an important tool to integrate land and water management through restricting potential threats to source water. However this is constrained by the fact that the responsibility for source water protection belongs to the ministry of water and energy and the fact that the land surrounding water sources are yet to be demarcated as public land.

Considering the fast growing nature of the municipality, slow responsive of top-level government and that there is no “one-size-fit-all” approach to source water protection, it is important to devolve source water management to municipalities. This will allow customisation and flexibility of actions that take into account the magnitude of threats and pathways and the potential risks. Of course there is the need for legislation to define a minimum standard for source water protection at all levels to prevent municipalities from compromising source water quality.

It is recommended that in the absence of technical data and financial resources for a comprehensive approach to source water protection, there is the need to adopt a precautionary approach at the local level given the presence of potential threats and pathways. We have proposed a framework that has some of the following potential advantages: provides clear leadership, provides a platform for multi-stakeholder engagement, institutionalises source water protection, pulls local resources together and enhances the municipality capacity to source external resources.

There is the urgent need to carry out a chemical and biological assessment of the water sources, as well as establish a repository for technical resources on source water protection.

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