Report into deaths in Epena district, Likouala Department, Republic of Congo

Summary Report

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Contents

Overview

During the period July-December 2016 communities in several villages in Epena district, Likouala department experienced a high number of deaths amongst children which they reported as abnormal[1]. Although several visits were made during this period by medical teams from CIB, and many children were treated or evacuated to hospital, an unacceptable number of deaths were unable to be prevented. To find probable causes for this event, and to seek interventions to avert a future repetition, an International infectious and tropical disease expert, Caroline Maxwell was commissioned by CIB-OLAM on the advice of The Malaria Consortium to carry out an investigation. Ms Maxwell was accompanied by a senior Congolese clinical epidemiologist from the Ministry of Public Health, a senior representative of the Ministry of Forest Economy, a logistical expert from CIB-OLAM, and an autochthonous social communicator. The field visit was undertaken in September 2017 with this summary report published in April 2018[2].

Scope of work

The scope of work was to identify as fully as possible all causes contributing to the deaths which occurred during the aforesaid period, to ascertain whether the building of a road which reached the village coincidentally with the start of the rainy season in July, and with the onset of the wave of deaths, could have contributed to the deaths, and lastly to assess whether the deaths were preventable and if so provide recommendations to mitigate the risk of this tragic situation arising again.

Key findings

Environmental assessment.

The villages are located on land almost entirely surrounded by flooded forest. The road presents a dry access route. Although each village varied slightly in situation the proximity of the flooded forest was a common factor in all, the difference being the extent to which the village was surrounded. Molembe and Mbandza villages were only separated from each other by a very short distance, but Molembe was entirely inhabited by autochthones, while Mbandza was a Bantu inhabited village. Inspection of the area along the road construction showed a number of water filled troughs produced by the tyre tracks of the heavy machinery used to construct the road. There were also several drainage channels from the road which had filled with water; we had purposefully timed our visit to coincide with the rainy season in the expectation of finding similar conditions to those found during the period when the deaths had occurred the previous year. Although the construction of the road provided areas for water to amass in heavy rain, and therefore create potential breeding grounds for mosquitoes, these water bodies are not significant in terms of risk given the villages were surrounded by flooded forest with its potential for breeding sites over hundreds of square kilometres.

[1] Unfortunately, there were no other records available for comparing the number of deaths in 2016 to previous years.

[2] Due to a temporary illness affecting vision Caroline Maxwell was unable to complete the report in October and it was completed in February 2018.

Overview (continued)

Population effects.

The autochthonous population spend their time between their activities in the forest and in the village; this necessitates spending periods of several days to weeks away from the village while fishing, hunting or conducting other forest activities. These cultural norms expose the people to different environments from those in the village, and locations even more remote from any healthcare facilities. According to members of Molembe village, some of the children who died had been in the forest and arrived at the village extremely sick. Other population effects observed were the significantly more crowded conditions in the houses of Molembe, the scarcity of adequate protection against cold or wet conditions (lack of bedding/ changes of clothes), and lack of a clean water source; in this respect there were two wells in the village of Mbandza but we were informed that the autochthonous community were discouraged from using these wells by the Bantu community. The autochthonous community tend to use traditional methods of healing which cannot cope with some of the diseases they had encountered. We found clustering of some deaths which had been caused by highly infectious agents such as measles or diseases which had probably arisen from a single source such as dysentery. Cooking frequently took place inside the house while babies and children were present. Charcoal and wood are polluting fuels with poor combustibility and highly toxic emissions. Household air pollution (HAP) is associated with both acute and chronic disorders, pulmonary and systemic including severe pneumonia in children

Epidemiological events.

Many families (29%) had experienced more than one death within the household within the period July – December 2016. Approximately 44% of these were attributed after verbal autopsy to dysentery; the deaths within families had occurred within a brief period of time, usually 1-2 days. The rest were attributed after verbal autopsy mostly to malaria, pneumonia and measles. The villages reported that there had been no vaccination campaign against measles for more than ten years. Some children had received a vaccine via the local representative of the order of the Maltese cross, however although we established the vaccine was against polio the people themselves were unaware of which vaccine their children had received, no vaccination cards appeared to have been distributed so we could not determine who had and who had not received vaccine, and according to the community not enough advance notice was received when there were campaigns by any party so many children would be in the forest and unavailable for vaccination. We were also informed in Bondeko that the clinic which the population generally used (Mokenge) frequently did not have any stock of childhood vaccines, so even when community members made the journey the vaccines were not available.

Health assessment.

The children in general were not in good health, this was especially true for the autochthonous population. It was apparent on first appearance that many were severely malnourished, and on further examination many exhibited clinical symptoms of heavy intestinal parasite loads. Malnourishment was exacerbated by the hierarchy in which the autochthonous population exist which places the Bantu at a higher level and able to expropriate any animals they have hunted and killed, and to allocate only a meagre inferior portion such as the head/offal to the hunter. The

Overview (continued)

environment predisposes to many diseases of different aetiological agents, and we witnessed clinical cases of blindness probably caused by onchocerciasis, yaws, leprosy, intestinal parasites, measles, polio. Within the timescale we could not take and analyse clinical samples (blood, urine, stool), however it is likely that there is endemic malaria, schistosomiasis and many types of intestinal parasites. During the rainy season in particular, pneumonia will be endemic. Due to the lack of available clean water sources and lack of behaviour change communication on hygiene, drinking and washing water was frequently collected from the same area as cleansing after defaecation. This situation was especially dire for the autochthonous population who were actively discouraged by their Bantu neighbours from using the water wells present in Mbandza which when we inspected had clean water.

Focus Group Discussions (FGD).

These were held with all communities, people talked freely in all villages without inhibition; all ages and genders were present, and everybody present in the village attended. The health situation in all villages regardless of the majority ethnic group inhabiting the village was dire. In general, due to their isolation the villagers relied on traditional medicine or 'western' medicine obtained from village kiosks. Traditional medicine can only help in some diseases, and mostly not those which were besetting the communities. The 'western' medicine was purchased with no form of diagnosis or knowledge on the part of the kiosk owner or the care-giver; the most common drugs purchased were either paracetamol or ibuprofen, which although helpful to alleviate some symptoms, cannot cure most of the diseases from which deaths had occurred. In addition, many of the drugs were from unregulated sources in countries known for producing drugs containing no active ingredients. The four villages Molembe, Mbandza, Itouzi and Mbeti brought patients to Loundougou clinic or Pokola hospital both of which are supplied with medicines and other materials by CIB-OLAM, or to Impfondu pioneer Christian hospital which took two days by pirogue and many children died en route. The village of Bondeko took their sick to Mokenge government health clinic which took five hours by pirogue, and again many children died on the journey.

The communities to some extent regarded different health issues as priorities, however all mentioned malaria, pneumonia (respiratory diseases), bloody diarrhoea, measles, gastro-intestinal disorders and rheumatism as major concerns. Leprosy, yaws and filariasis (onchocerciasis) were also mentioned by some communities. All villages expressed a strong concern that most of the health issues were borne by the children, and that their condition worsened with rapidity, and that they felt powerless to help them.

A separate group discussion with the women of Molembe revealed a critical situation regarding nutrition. The autochthones work in the fields for the Bantu due to the caste like system of hierarchy. The payments received are very low and totally inadequate for provision of food. In addition, the autochthones often hunt with modern weapons from the Bantu which obliges them to sacrifice the animal hunted to the Bantu for which they are 'paid' meagre and unwanted parts of the animal. The women had organised their own plot of land to cultivate but this reportedly had been taken by the Bantu. This is a situation which is culturally ingrained but needs to be rectified with immediate urgency and the whole-hearted support of the government as the suffering caused is immense and a major contributor to the appalling health of the autochthonous people. The women also complained that their men tended to misuse money on alcohol. Additionally, the eco guards were often reported as being aggressive towards the autochthones, and sometimes beat them or stole their hunted animal despite the autochthones being legally allowed to hunt for their own needs.

Overview (continued)

Key Informant Interviews

Key Informant interviews were held with the village chiefs and medical staff at one of the clinics and hospital accessed by the populations. Verbal autopsies were carried out with the care-givers, usually the parents, of the children who had died. Deaths occurring during both 2016 and 2017 were noted and interviews conducted for all but analysed separately. Health issues raised by the village chiefs reflected those of the community in terms of diseases considered the main problems, and the logistical difficulty of transporting patients to any of the health centres/hospitals was a major impediment to timely treatment being sought. Even with the new road the villages did not possess any vehicle or fuel to enable them to access the clinic and hospital. Medical staff interviewed re-iterated the very poor health of the populations in this area, especially the autochthones.

The verbal autopsies conducted revealed the desperate situation regarding treatment of any illness. Not a single autochthone household had accessed a health centre or hospital, and most had relied entirely on traditional medicine. Most of the deaths that occurred were preventable. Although some deaths, especially dysentery, had occurred during a brief time period had there been access to a functioning health system these deaths were preventable. Likewise, those determined as probably malaria or pneumonia were preventable with inexpensive treatments available in country as part of the national government health system, and in the CIB-OLAM supported health facilities.

The underlying poor health condition of the children, especially autochthones, was recognised by their families, and the vulnerability of children already beset with malnutrition and intestinal parasites should not be underestimated.

After interviewing the families who had lost children during 2016 it was clear that many children had died in the Bantu villages as well as the autochthone village of Molembe.

The families of 34 children who had died in Molembe were interviewed and it was confirmed that these children had died during the period June-December 2016. We were informed of a further 11 children who had reportedly died during the same period but whose care-givers were absent for interview. In Mbandza, a Bantu village immediately adjacent to Molembe we interviewed the families of 20 children who had died during the same period, a further 7 had died during January to May 2016 and 5 whose care-givers were unavailable for interview were reported as deaths during the period June-December 2016. The Bantu hamlet of Itouzi reported 9 deaths during 2016, and of the 5 whose care-givers we were able to interview 4 had died in November/December 2016 (1 in May 2016). In Mbeti 9 deaths had occurred in 2016 of which 7 had occurred during the June-December period, and in Bondeko all 12 deaths reported and interviewed regarding were during the June-December period. The villages of Itouzi, Mbeti and Bondeko were several (increasing respectively) kms beyond the road and the tragic increase in deaths was evident in all five villages. Accurate population data for each village was not available however in order of population from smallest to largest the order is Itouzi, Mbeti, Mbandza, Bondeko, Molembe, so although the death rate was probably higher amongst the autochthonous population of Molembe it was not extremely disproportionate to the other villages.

After conducting verbal autopsies, it was clear that there were multiple factors contributing to the high death rate, however the final cause was split mainly between dysentery, malaria, pneumonia and measles with each village experiencing a different proportion, however Molembe and Mbandza were especially badly hit by dysentery and pneumonia. Since the autochthones are discouraged from using the wells it suggests both they and the Bantu of Mbandza were infected with dysentery from another source. Normally the semi-nomadic autochthones would move from a disease outbreak, however in the novel situation of living in a village they are confined with the disease. Chronic anaemia caused by malnutrition, intestinal parasites and malaria was evident in all villages.

Overview (continued)

The reason for the spike in deaths in all five villages is not clear, and how frequent such a spike in deaths occurs in these forest villages is not possible to determine with no records available for previous years. However, the general health of the populations, especially children is so poor that they cannot resist any disease which they encounter. Dysentery is generally more prevalent during the rainy season, pneumonia and other respiratory tract infections are often more prevalent, and malaria during and after the rainy season. Children who are malnourished, not vaccinated, anaemic and exposed to HAP are likely to succumb to any disease which they encounter without rapid access to appropriate treatment, and it is these underlying problems which need to be addressed.

Mosquito sampling

There was insufficient time to conduct a thorough search of the potential breeding sites. Several hours were spent searching in the flooded forest and in the water bodies left by the heavy machinery tracks and drainage channels, however mosquito larvae were not found. This was likely due to the rains washing the larvae away, as during the period we were there it rained most days. We also tried to sample adult mosquitoes using standard human landing catches, however due to the rainy conditions the mosquitoes were not flying.

Assessment of long lasting insecticidal mosquito net (LLIN) ownership and condition

The government organised mass distribution of LLINs had not reached most of these villages, only one village reported receiving nets (Bondeko), but only 9 nets for the entire village. Some women had been given nets through the ANC free net distribution. Many households had purchased nets, many of these were bought in Pokola market and were unauthorised LLINs from the mass distribution in neighbouring DRC. Coverage was low with most people, including children not using an LLIN. The LLINs were of varying ages, 1-3 years old, and many were in very bad condition. Mosquitoes were an age-old nuisance but the ability of the households to afford a net was low.

Challenges in the assessment

The assessment was time-constrained, and it would have been useful to conduct a clinical examination of blood/urine and stool to determine the range of diseases affecting the population. It would be helpful to know the mosquito species present to determine which interventions would succeed in preventing malaria. It was described to us that some of the children who died had been residing in the forest, a more thorough research should be conducted regarding this, and it would have been useful to have an accurate census of each village as death rates could not be calculated.

Recommendations

There are many challenges, however many are relatively simple and inexpensive and could have a major impact.

Recommendations	Challenge
Provision of clean water source in Molembe village.	
Although a pump is recommended, this needs maintenance requiring technical knowledge and access to spares. How this would be guaranteed needs to be considered prior to deciding to install a pump. Wells are also satisfactory but need to be dug sufficiently deep as to assure clean water and to be safe from storm water draining into them, and from people falling into them.	With the advent of the road the government supported scheme for provision of clean water, “water for all” should provide this; the understanding between the villages and the government was that the road was required for the government to provide clean water sources. However, a timescale needs to be determined in case an interim measure is needed as this is urgent and the scheme had been temporarily halted.
Improving local access to health care	
Highly trained and well-equipped community health workers are essential in this remote environment. Project Bwanga is an excellent asset and should be a basis for increasing capacity to ensure illnesses are diagnosed and treated rapidly, and if necessary referred to the dispensary or hospital. The medicines held by the Bwanga CHWs were well chosen, although the addition of rectal artesunate should be discussed with the MoPH (it may not be licensed in RoC although it is in DRC) as this can give a child an extra lease of time to reach a health facility when severely sick with malaria.	Ways need to be explored whereby the community members feel comfortable accessing the services and paying the contributory fee for medicines. Likewise establishing that the CHWs trained are willing to take on their role conscientiously which requires their availability and patience and ensuring they can carry out their work effectively under difficult circumstances. Challenges are finding the right persons to take on these roles and habituating the users to paying the affordable fee; suggesting ways in which they can obtain the fee (such as collection of certain leaves as proposed by the Bwanga team).
Improving access to health care	
Loundougou is less than 2 hours by 4x4 even during the rainy season, however there were no vehicles in any of the villages. Accessibility of the villages by road is only one aspect of improving the movement of the village people. This could be managed in many ways depending on resources and the willingness of the Government and stakeholders to reach a solution.	Coordination between the Ministry of Public Health, stakeholders and villagers regarding the most economical and sustainable way to make transport available. Challenges are availability of fuel, maintenance of a vehicle, avoidance of misuse, payment of a driver and possibility of accidents. Motorbikes are used in many countries for transporting sick persons, however this depends on the severity of the illness and on a mud road in the rainy season there is a high potential for accidents. A motorbike ambulance is another alternative.

Recommendations (continued)

Improving use of health care facilities

The autochthones especially are unaccustomed to using western medicine or health facilities. Use of traditional healers trained in selected common western disease diagnosis and treatment as with project Bwanga effectively links traditional and western methodology. However considerable effort to accustom the communities to consulting these health workers, and to the necessity of their recuperating costs with a minimal charge, as well as easier access to higher level health facilities is needed. The Bantu communities also need health education as often their previous resources were wasted on inappropriate medicines or efforts to transport the child when it was too late.

Behaviour Change Communication needs to be consolidated with the MoPH and expertise sought. An unnecessary challenge is that most of the health workers are Bantu and are not necessarily polite to the autochthones; health workers should be non-discriminatory and this needs to be emphasised in their training.
The issue of food security for in-patients undergoing treatment is an issue as the treatment cannot be completed if the patient or care giver does not have resources to find food.

Provision of long lasting insecticidal mosquito nets

LLINs should be provided to all households at a rate of one net per two persons. Net sizes appropriate to the living conditions should be purchased. It is preferable to use a team to assist householders in hanging the nets appropriately.
To maximise the potential to prevent malaria all households should be using LLINs. Theft or selling of LLINs must not be tolerated; nets should belong to the village and not be personal possessions. Since the autochthones spend considerable periods in the forest it may be investigated whether insecticide treated hammocks could be used, or nets external to the dwellings as some of the children who died from malaria may have contracted it in the forest.

The communities were used to sleeping in LLINs and had purchased LLINs when possible. The nets were often very sooty from cooking fires within the house and instruction on washing nets should be given. The soot may render the insecticide inert. It is a challenge to protect the autochthonous communities while they are living in the forest however hammocks or strong nets which could be used outside their forest houses should be researched for effectiveness and availability.

Improving technical knowledge

Research on the diseases present, seasonality and prevalence should be undertaken. This will require a survey by a clinician and trained technician to examine blood, urine and stool samples. In addition, further research on the mosquito species present in the area and breeding sites should be sought as well as other vectors of disease (blackfly, tsetse, snails etc.).

It would also be helpful to ask about eating habits (what species of animal are eaten) and any evidence for the presence of haemorrhagic diseases.

With good knowledge on the prevalence and repertoire of diseases present, and their vectors, better judgement on the best use of resources for interventions to protect the population can be made. The population seemed receptive and I would not anticipate a challenge with obtaining samples. As much as possible rapid tests should be used with traditional samples also taken for later confirmation, and treatment given the same or next day. Sufficient advance warning must be given to allow the autochthones to receive the news of the proposed survey (several days to ensure those spending time in the forest are made aware).

Recommendations (continued)

Assuring equity

The hierarchy exhibited between the Bantu and the autochthones is a critical factor in the poor health of the autochthones. This is a contentious and delicate issue. The hierarchical relationship between the Bantu and autochthones is a multi-generational established relationship and difficult to erode, but highly detrimental to the autochthone society. The relationship is multi-faceted and a subject which requires advise from an anthropologist with expertise in Baku customs and the Baku-Bantu relationship.

This issue needs full and active backing of the government to assure equity. The way in which equity can be achieved is not within my capacity to advise, however this is an urgent and critical issue to address and reflects poorly on the Republic of the Congo. It is therefore an issue which the government must want to prioritise.

Ensuring vaccination is provided to all children for preventable illnesses for which vaccination is available.

The only recent campaign we were notified of was polio. Many children were suffering from measles during 2017, and many had died. We tried to organise a campaign for measles with the Ministry of Public Health and the Expanded Programme of Immunisation while we were there but failed. The MoPH is responsible for campaigns and in 2016 received funding from GAVI (vaccine initiative) and support from UNICEF. The entire country was having outbreaks of measles, and this situation had been noted since 2015, and measles cases were still occurring in 2017 during our visit. Routine vaccination was also not optimally operating; many mothers reported attending childhood clinics to receive the childhood immunisations, but the clinic had a stock out – this was reported for Mokenge. Vaccine was always available at Pokola but it was logistically and economically difficult for mothers to reach Pokola. This situation must be resolved with the MoPH and stakeholders such as UNICEF/EPI/GAVI.

This is a MoPH responsibility supported by EPI and UNICEF, the reasons for the failure of the system both routinely and in mass campaigns needs to be researched in close coordination with the partners responsible. Any corrective action will be based on the reasons found.
We did not visit Mokenge due to time limitation and whether there are adequate vaccine storage facilities is uncertain. Remote clinics in other countries are usually supplied with solar powered fridges with a solar powered battery back-up for the night. The communities complained that when there had been a campaign there was inadequate advance notice. There were not many radios present in the villages, and ways of disseminating the announcement appropriately to both the Bantu and autochthonous communities need to be investigated. Remote communities communicate amongst themselves, so the same methods may be appropriate.

Recommendations (continued)

Periodic treatment for intestinal parasites

Soil transmitted helminths (STH) are a major source of morbidity in poor rural communities and contribute to malnutrition, anaemia, cognitive disorders and resistance to other diseases. Anthelminthic treatment is inexpensive and usually safe, and very effective. The treatment needs to be organised regularly i.e. 3 monthly. Mass administration of anthelminthic is often to school age children (SAC) however in the Mbandza area many of the children do not go to school, and it was also evident that many pre-school age children (PSAC) were heavily infected and they can develop serious disease. Treatment is recommended to be community wide at least including the age group 1-14 years. If possible treatment of adolescents and age groups should take place, however this is complicated as anthelminthics cannot be given to pregnant women. Treatment for schistosomiasis can be given concurrently however an initial survey should establish if schistosomiasis is endemic in the population. There is no paediatric preparation at present therefore treatment of PSAC requires special preparation.

An anthelminthic programme must be led by the MoPH; all drugs can have side effects and anthelminthics can cause quite serious side effects, especially in malnourished or already weakened children. Although the side effects are not fatal and only affect a proportion of those treated, they can be serious (such as unconsciousness) and therefore a doctor and nurse should be present during treatment and for several hours after until it is certain no further people will exhibit side effects. A detailed plan should be developed with the MoPH depending on their regulations, and they should oversee the treatment and hold responsiblity.

Improving sanitation

There were very few pit latrines in any of the communities, and many people used the forest as a toilet facility. The autochthones regard toilets are repugnant; the idea of collecting urine and faeces in one place is alien to their culture. Dysentery was a major cause of morbidity and mortality in the villages and the collection of drinking water and defaecation occurring in close proximity is a major concern. Village meetings with the mainly Bantu occupied villages would ascertain their contentness with the option of pit latrine provision to villages. For Molembe, inhabited by autochthones village discussions must take place and a solution sought as to whether a designated area rather than one place could be assigned for use as a toilet area; this needs to be chosen so there is no possibility of the water collection area being contaminated.

Pit latrines are not especially expensive to build, however they require maintenance to keep them in a clean state; they can also be a source of mosquito breeding (Culex quinquefasciatus – non malaria transmitting but can transmit other diseases). Generally rather than having ‘village owned’ pit latrines which often are not looked after it is preferable to have a pit latrines assigned to individual or a small number of households. Issues such as these need discussion with the village communities – the upkeep depends often on the village leadership.

For the autochthones for whom pit latrines are abhorrent an alternative solution must be found which will require discussion with the community and a survey to ensure contaminated water cannot enter drinking water source which is especially difficult to prevent in the rainy season.

Recommendations (continued)

Health education on sanitation

The prevalence of dysentery and STH in the communities suggests that health education on basic concepts such as washing hands after using the toilet needs to be instigated, and assurance of the availability of water for this purpose. Depending on other diseases found to be present health education on preventative measures which are appropriate to the diverse cultures should be given. Cooking was frequently observed within houses while children were sleeping, and the smoke is known to cause an increased risk of respiratory disorders which may be fatal.

Health education needs to be appropriate and attainable. Frequently 'advice' is given which is beyond the reach of the individual – if advice is given regarding nutrition the available and affordable food sources must be those considered, although if other crops can be grown in that area and are agreeable to the community advice on growing these may be included.

Regarding diseases such as schistosomiasis ways of mitigating the risks must be discussed with those most at risk of obtaining the disease so that ways which are accepted by them, and alternatives to the risk behaviour are sought.

Ecoguards

It was reported by the autochthones that although they were allowed to hunt for food in designated areas, the ecoguards frequently harassed them, sometimes beat them, and sometimes confiscated (stole) the animal which they had hunted. We were surprised that the ecoguards were mostly Bantu, although those with superior knowledge of the forest and the ecosystems within it were autocthone. This is a serious problem which has been reported in various areas of RoC for decades. It appears to be a reflection again of the hierarchy in which the autochthones exist. The Government is ultimately responsible for the ecoguards and should be engaged in dialogue to 1. Educate the ecoguards to try and reduce the effective racism which seems to be expressed by some of them, and 2. Consider including autochthones as ecoguards if this is agreeable to the autochthonous communities. Ecoguards who exhibit discrimination against autochthones should be punished and a system of reporting such offences with documented consequences should be initiated.

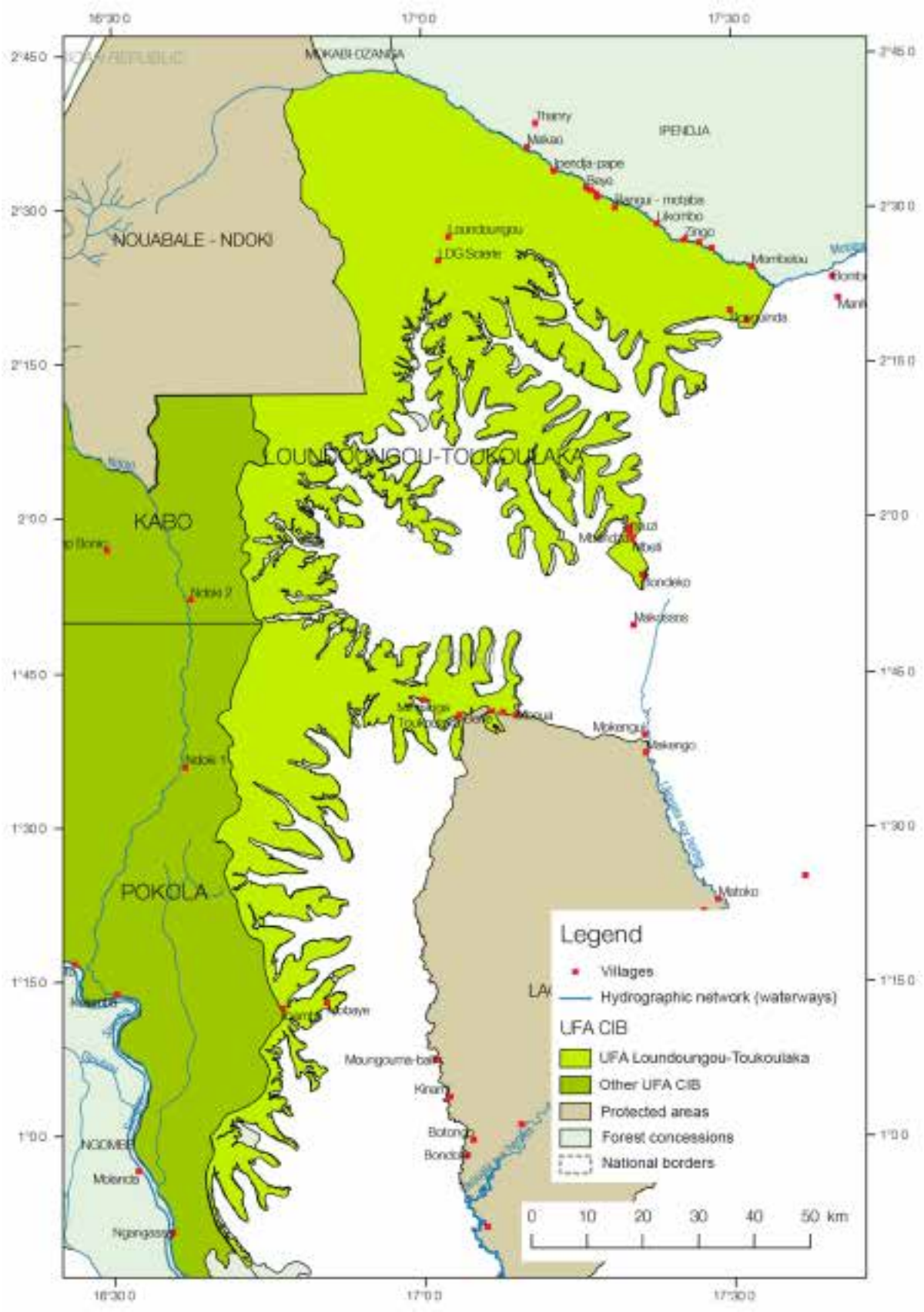
This is likely to be largely due to the inferior status of autochthones in the eyes of some of the ecoguards and is a difficult issue to resolve. Full and active backing of the government needs to be attained and the government should lead in discussions with ecoguards, autochthonous communities, logging and other companies operating in the area, and wildlife/ conservation organisations to produce a meaningful and attainable way forward.

Recommendations (continued)

Reduction of household air pollution (HAP)	
Culturally acceptable solutions which are specific to the environment of Epena district should be sought. Pellets made from wood or crop residues are much more efficient at burning and may be a possible intervention considering any waste produced by the production of planks in the logging industry. There are many cookstoves with greatly improved efficiency compared to the three-stone arrangement which was common in the villages we visited. These can be produced locally and inexpensively. Improved ventilation should be recommended but is not always easy to apply. Biogas is a clean fuel, but substantial initial investment is required.	Those responsible for cooking need information on why they should adapt to using different fuels or cooking methods, change is always a challenge but the effect of HAP is highly detrimental, not only to babies and children enveloped in the fumes, but also to the mostly women who do the cooking. Light sources such as kerosene lamps and candles can also result in substantial HAP and as far as possible alternatives should be made available.

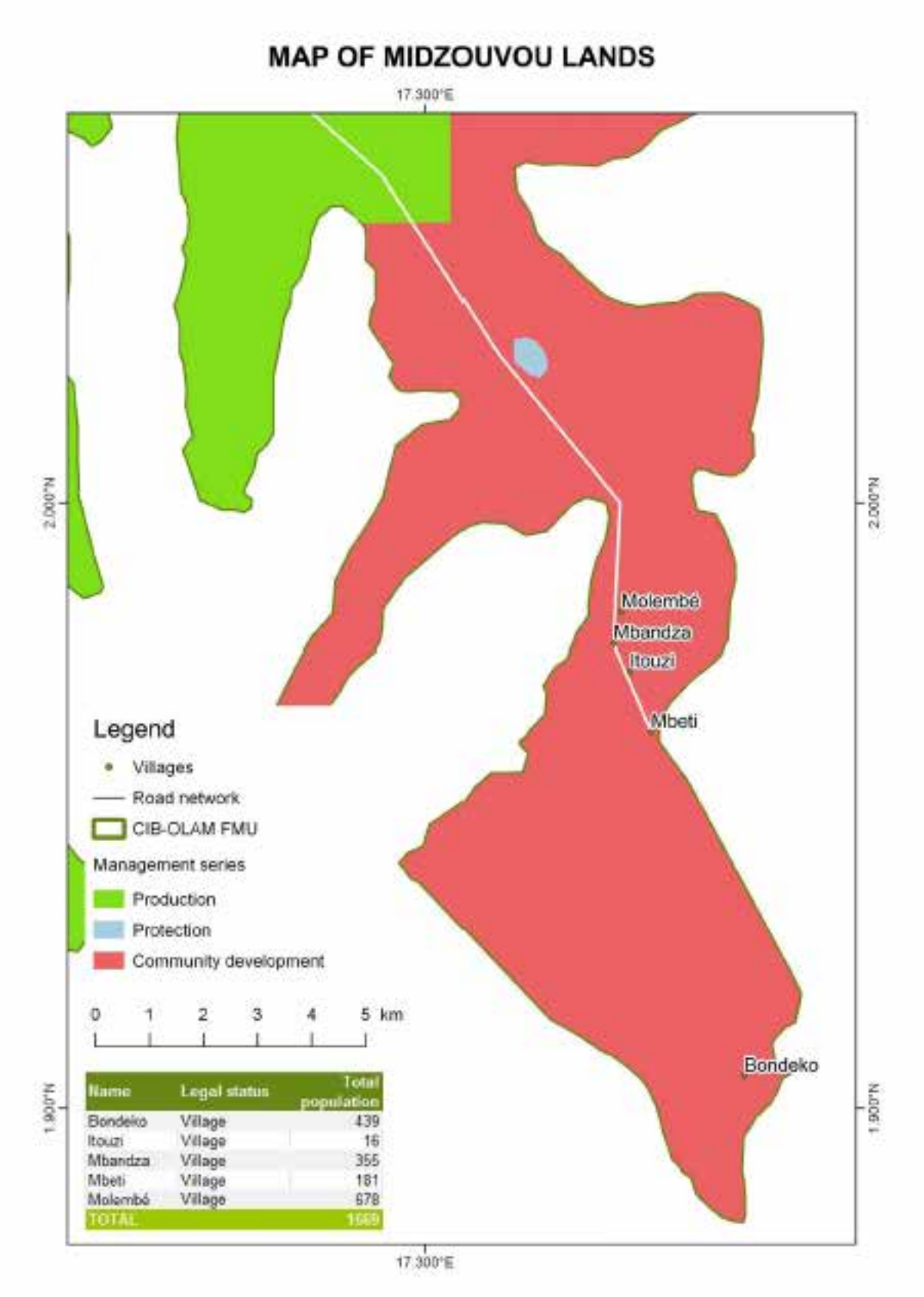
Annex 1 Maps

Map 1: Map of Loundoungou-Toukoulaka Forest Management Unit (FMU)”



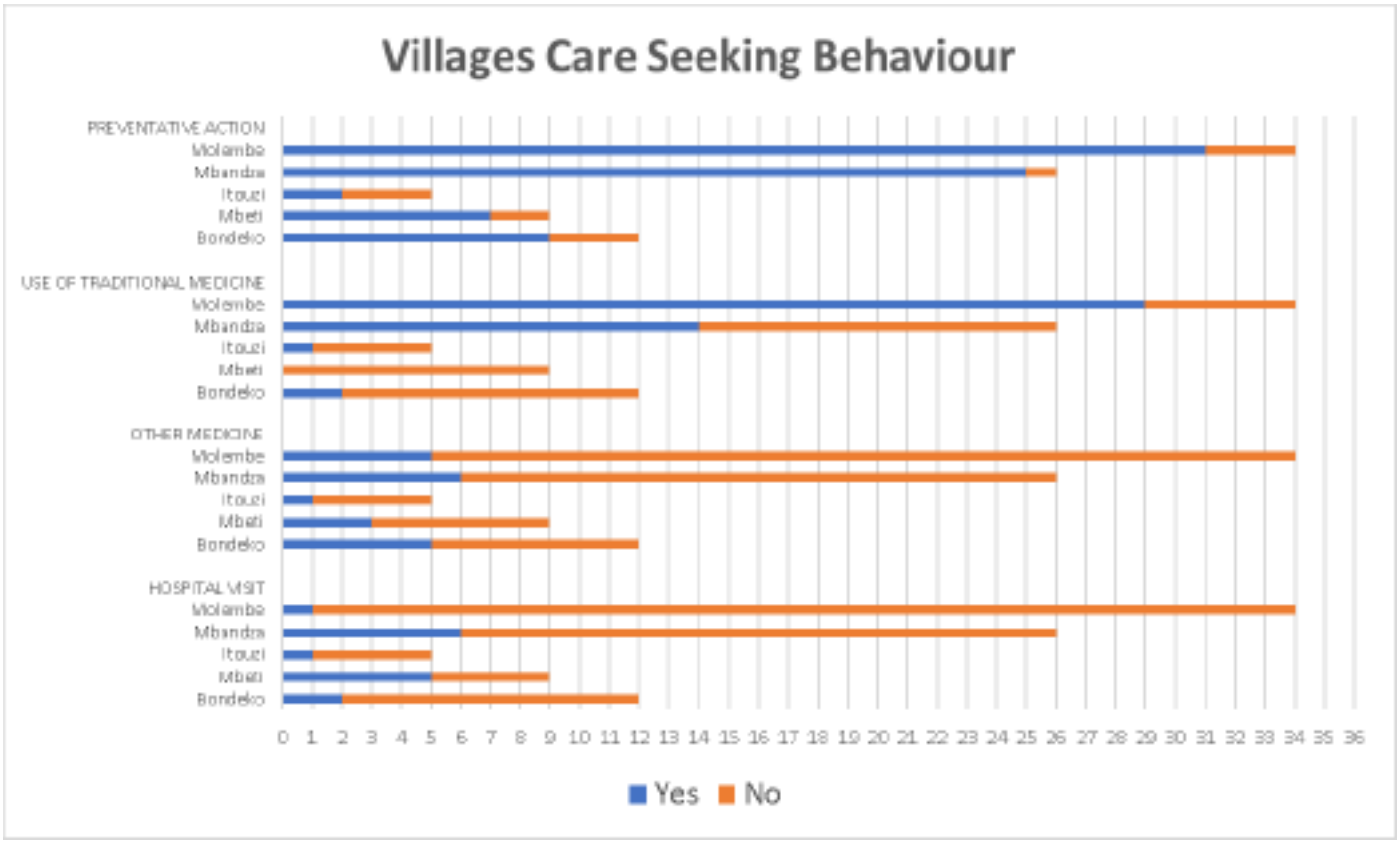
Annex 1 Maps (continued)

Map 2: Map of Midzouvou Lands



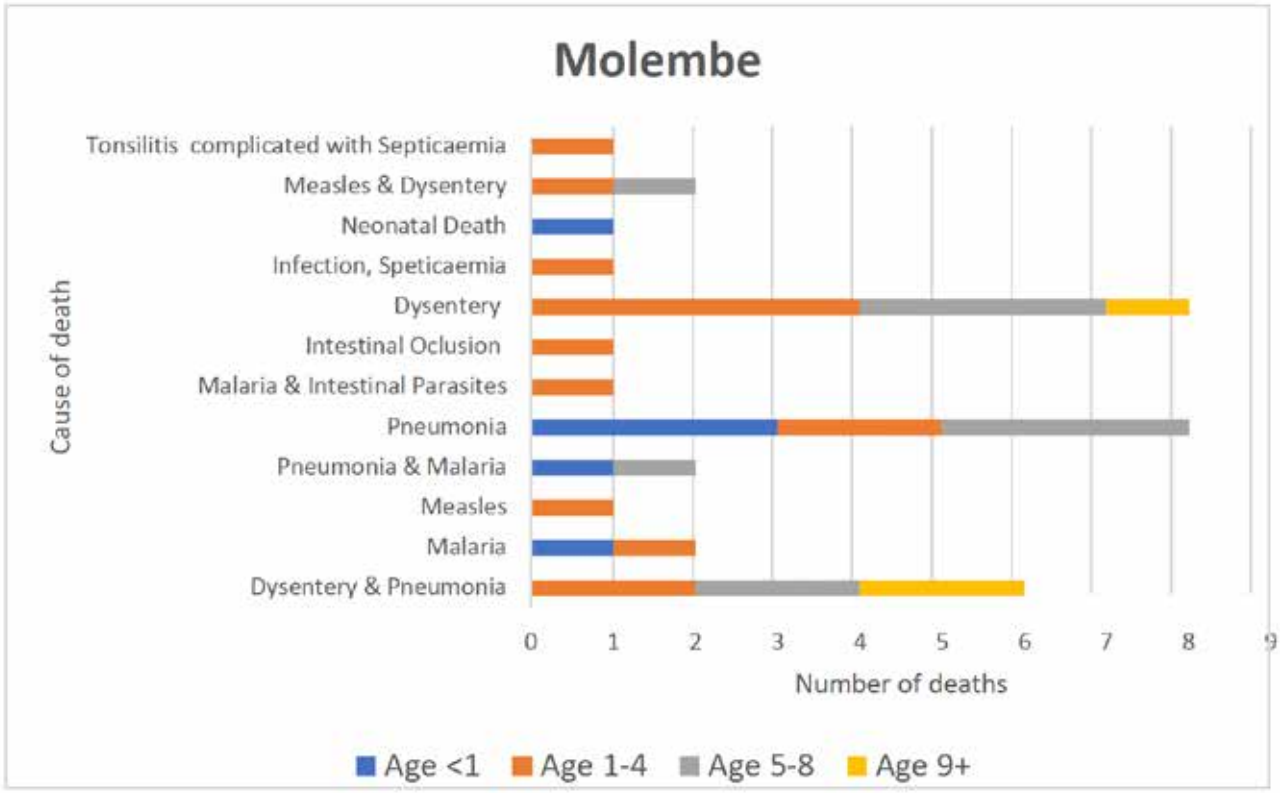
Annex 2 Graphs

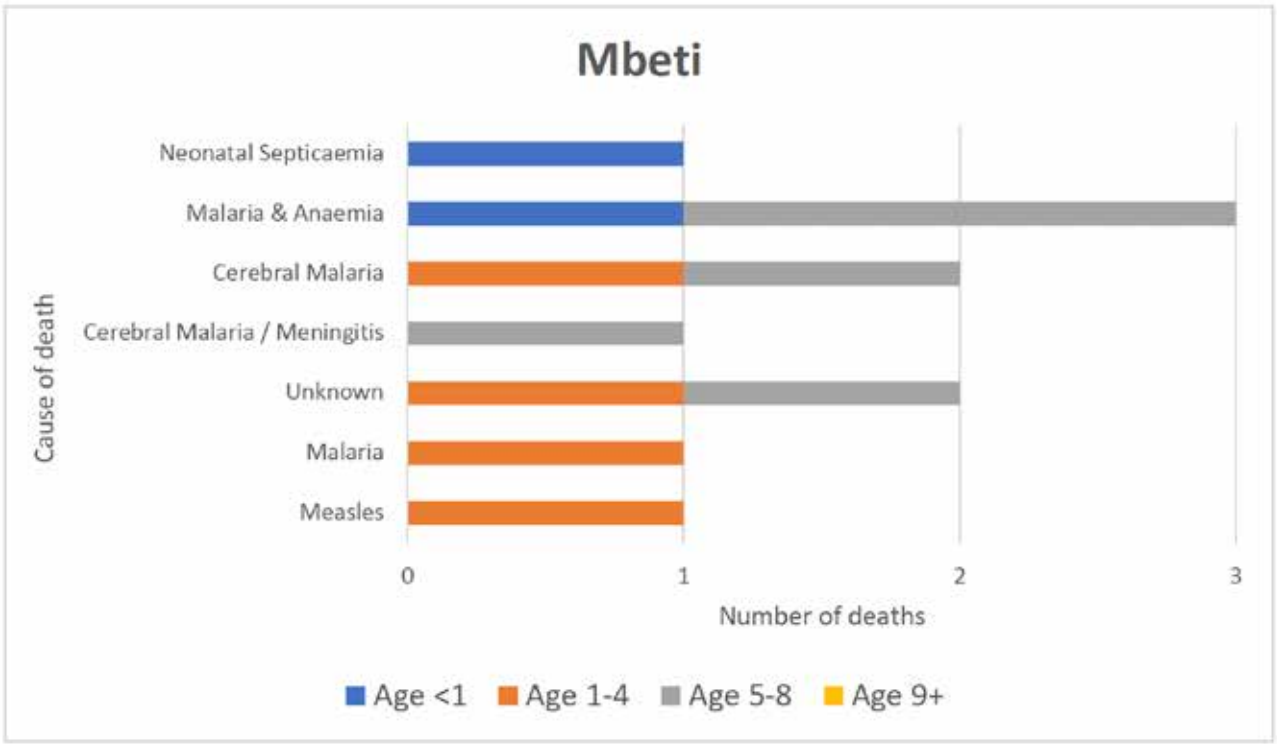
Graph 1 – Villages Care Seeking behaviour



Annex 2 Graphs (continued)

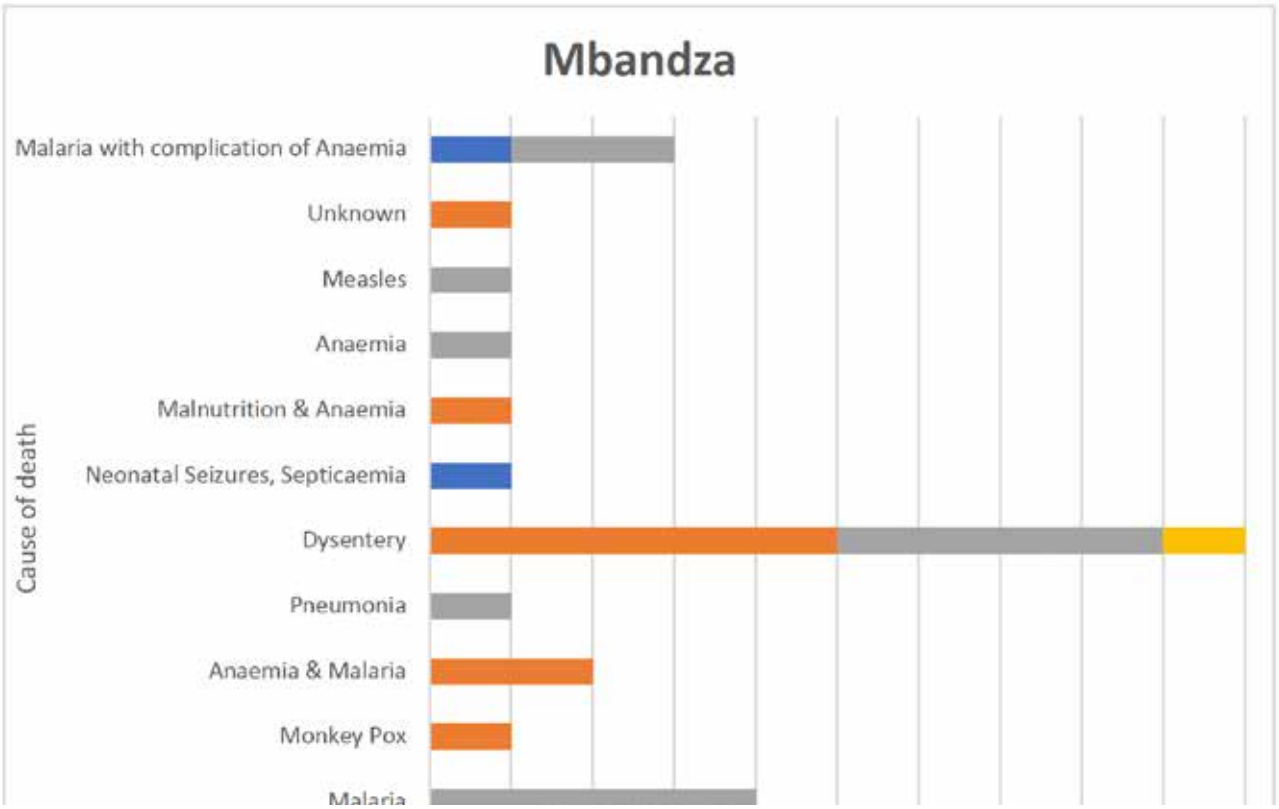
Graph 2 – Assigned Diagnosis by village - all diseases or disease combinations assigned to the deaths

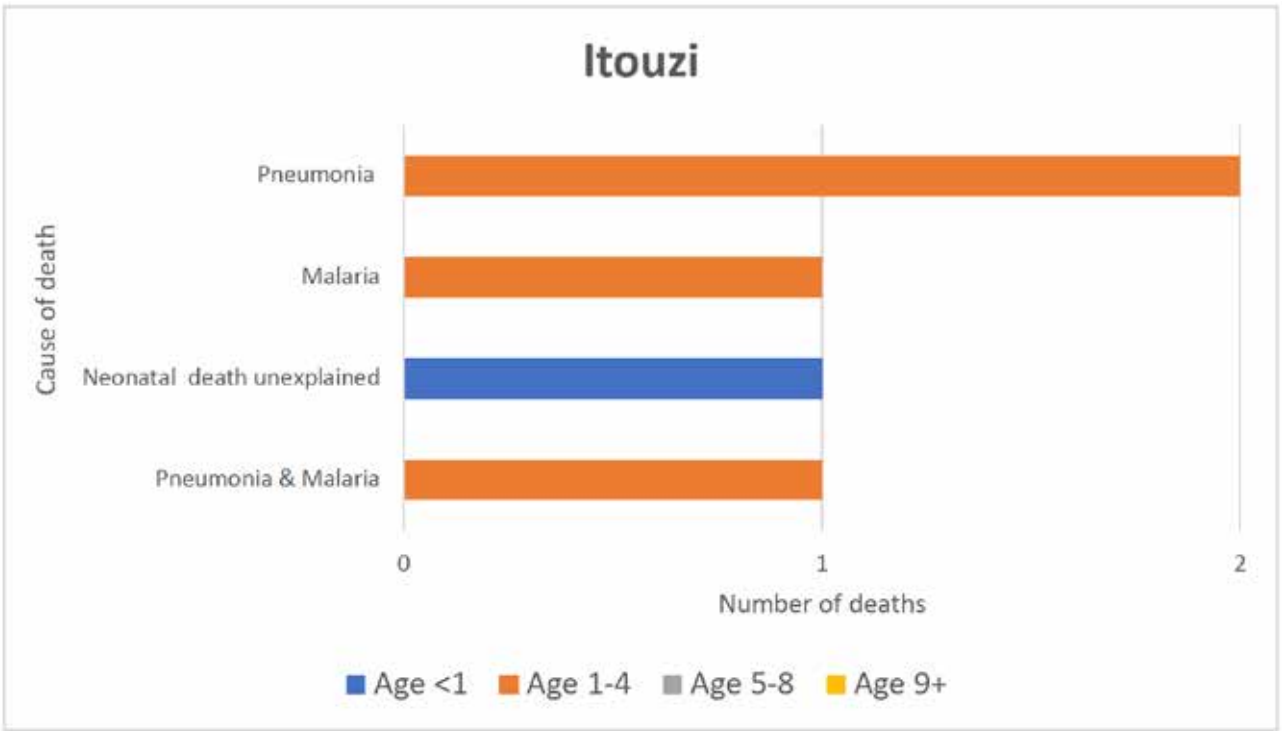




Annex 2 Graphs (continued)

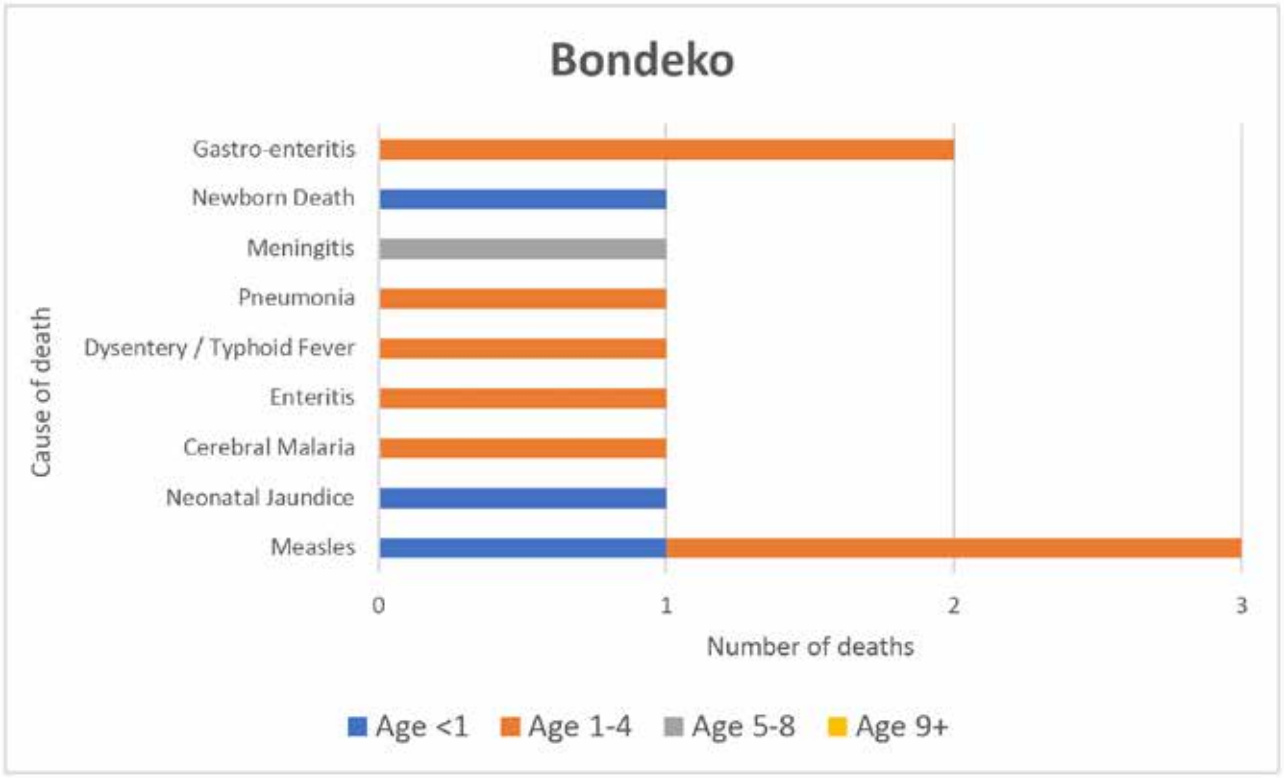
Graph 2 – continued





Annex 2 Graphs (continued)

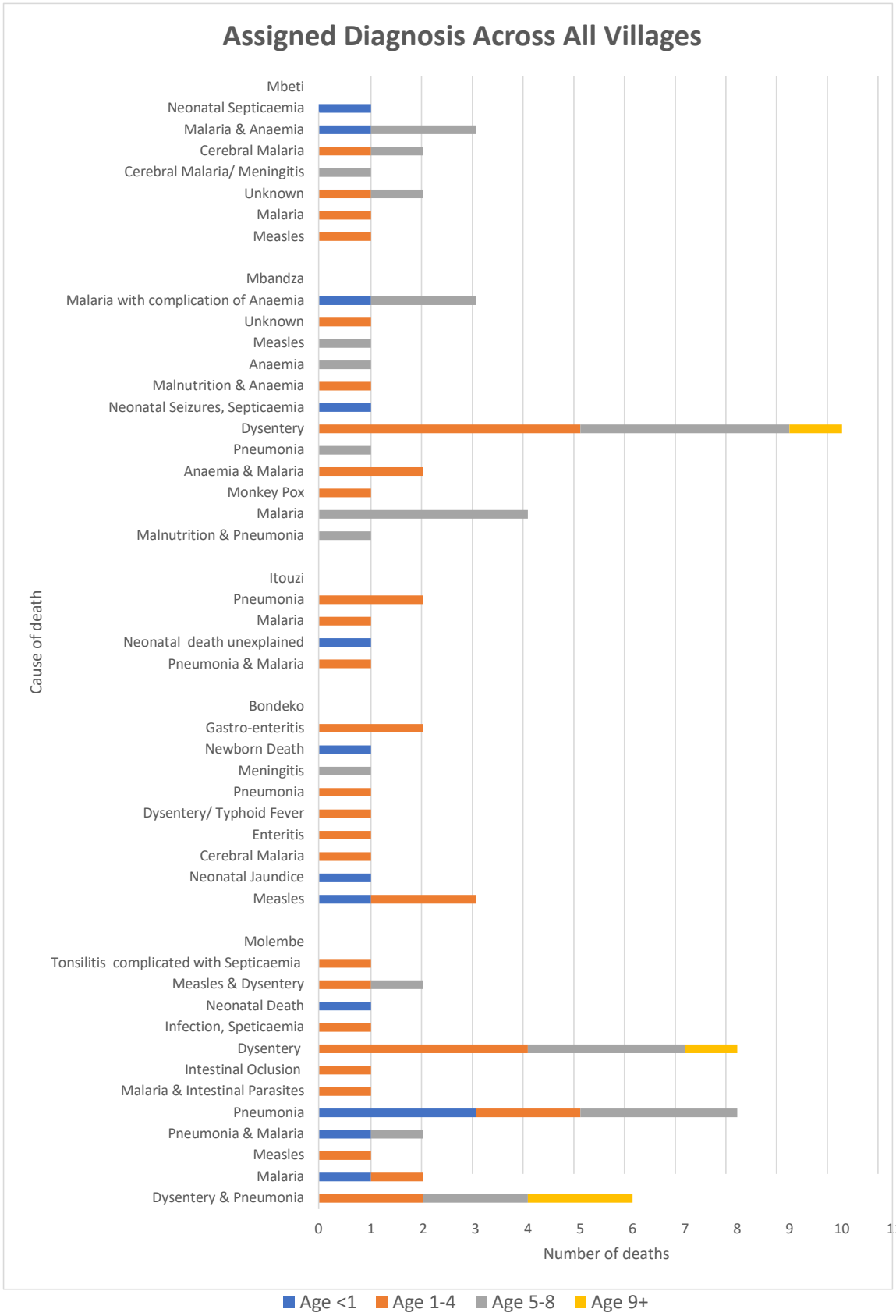
Graph 2 – continued



[7] The IUCN categories are defined here: https://www.iucn.org/theme/protected-areas/about/protected-area-categories

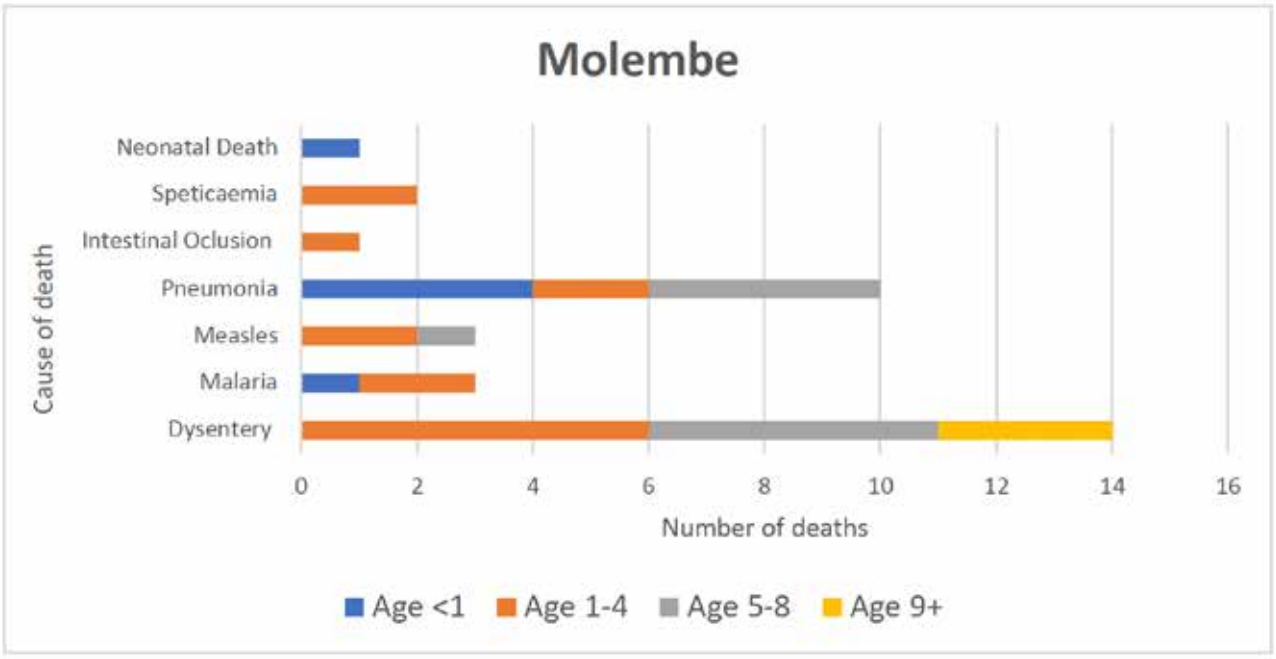
Annex 2 Graphs (continued)

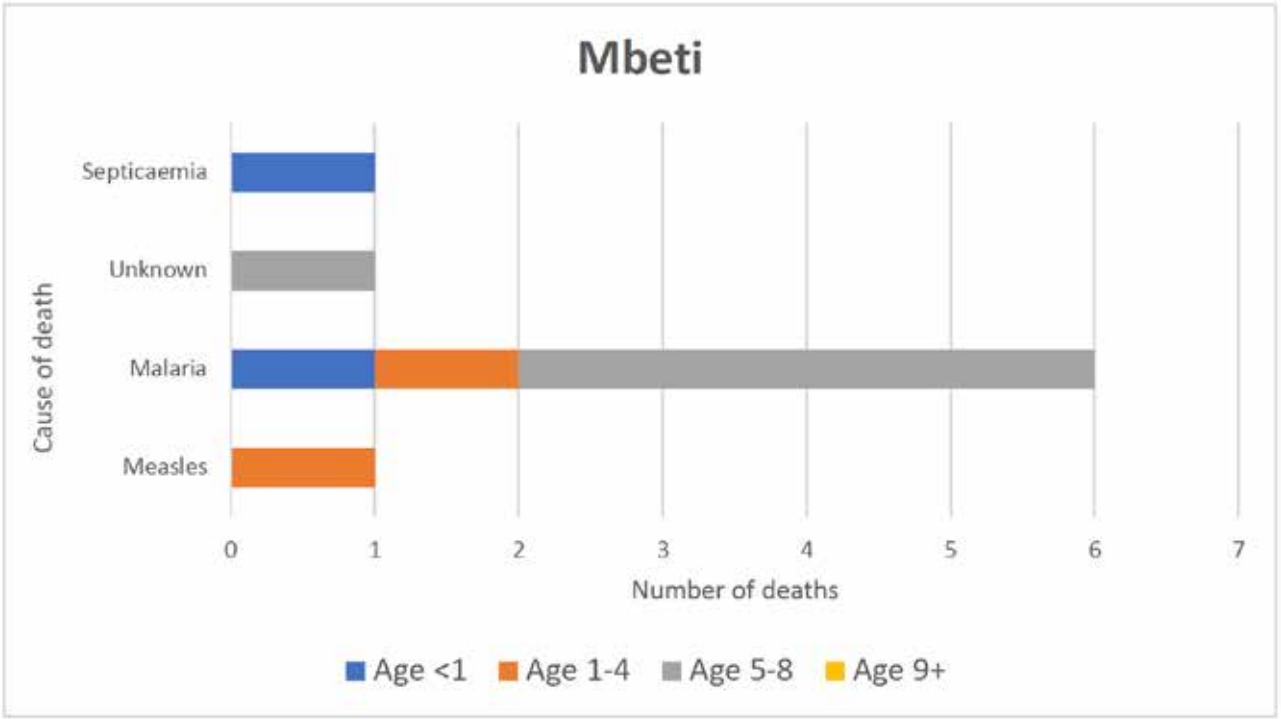
Graph 3 – Assigned Diagnosis across all villages – all diseases or disease combinations assigned to the deaths



Annex 2 Graphs (continued)

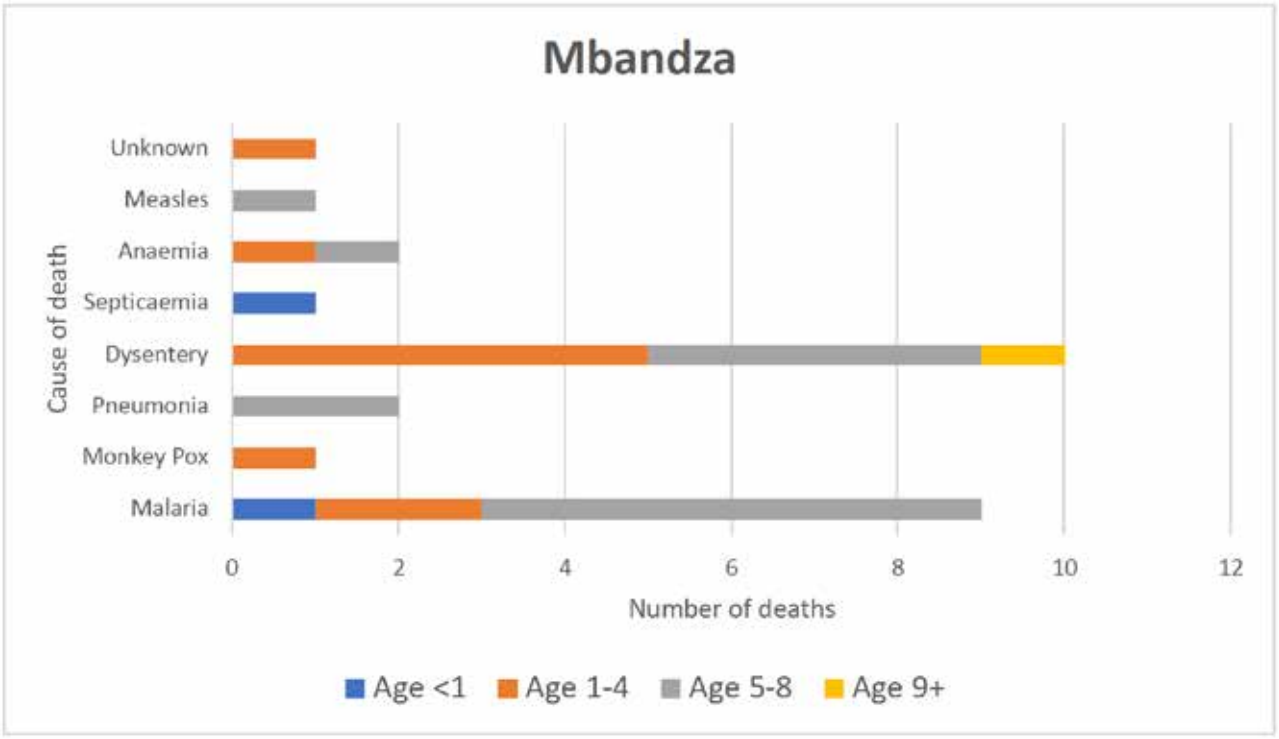
Graph 4 – Major contributor: Probable principal cause of death assigned by village

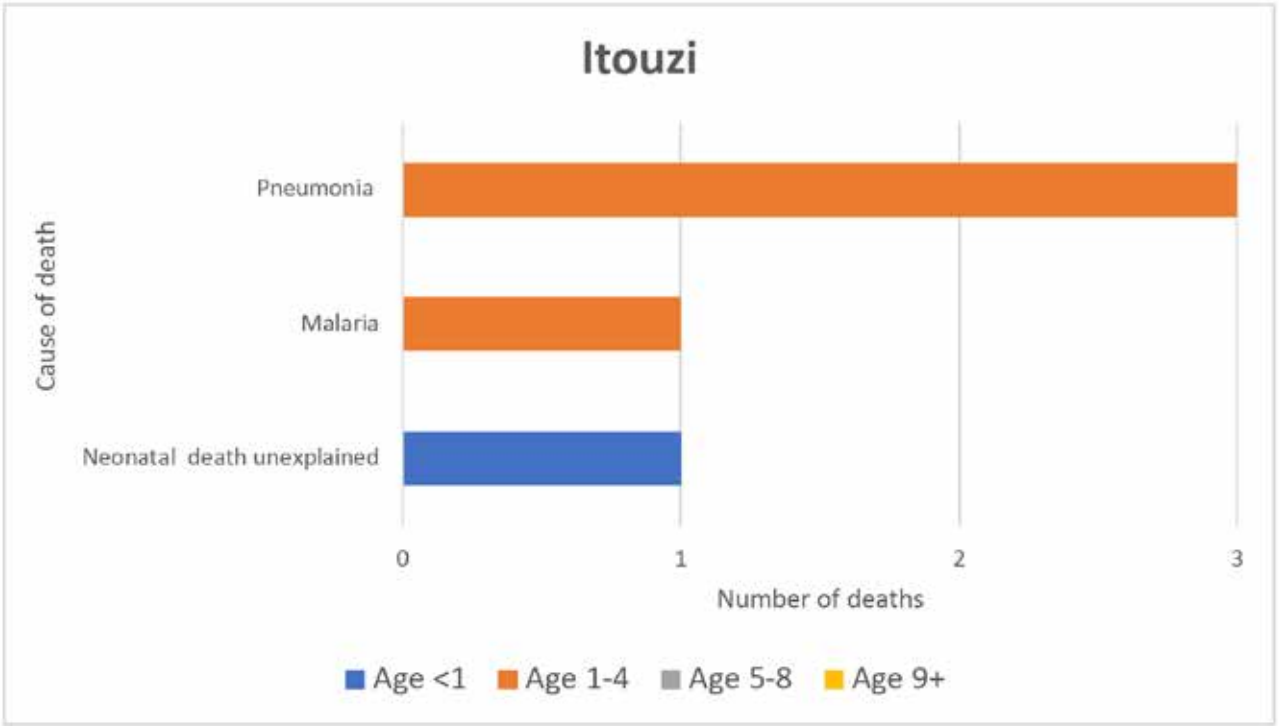




Annex 2 Graphs (continued)

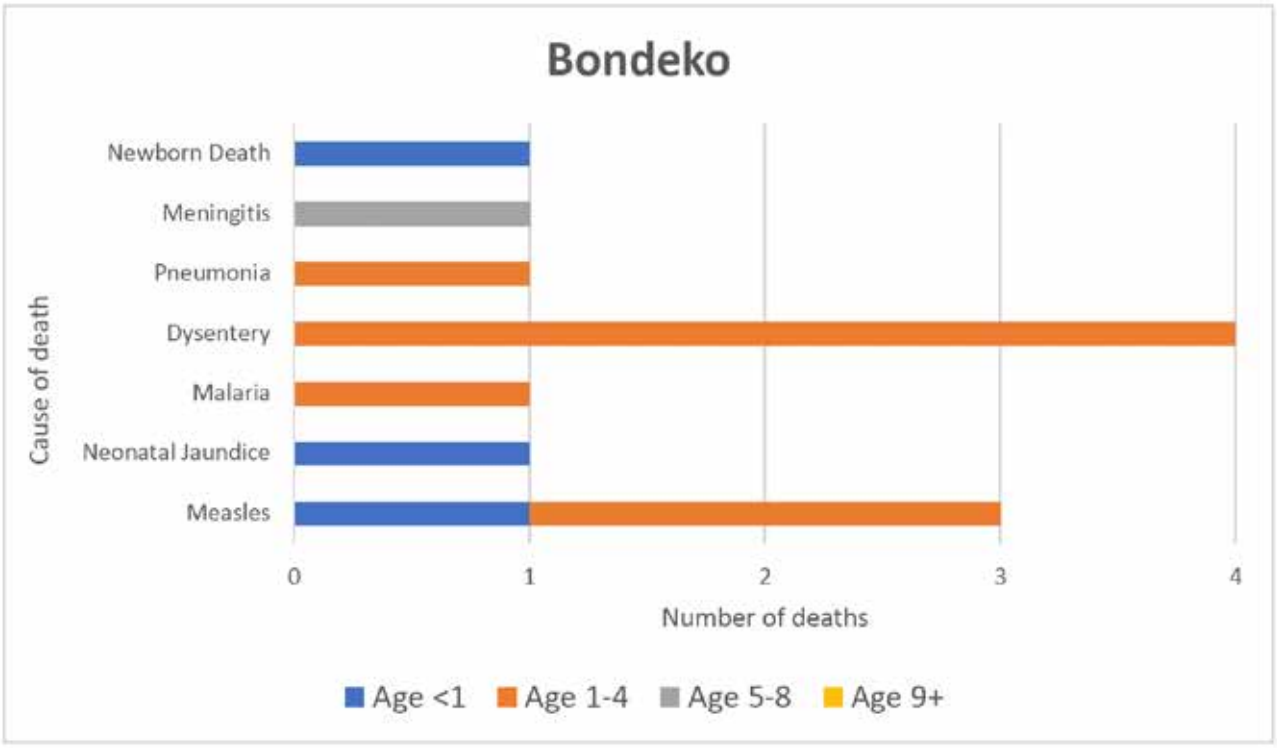
Graph 4 – continued





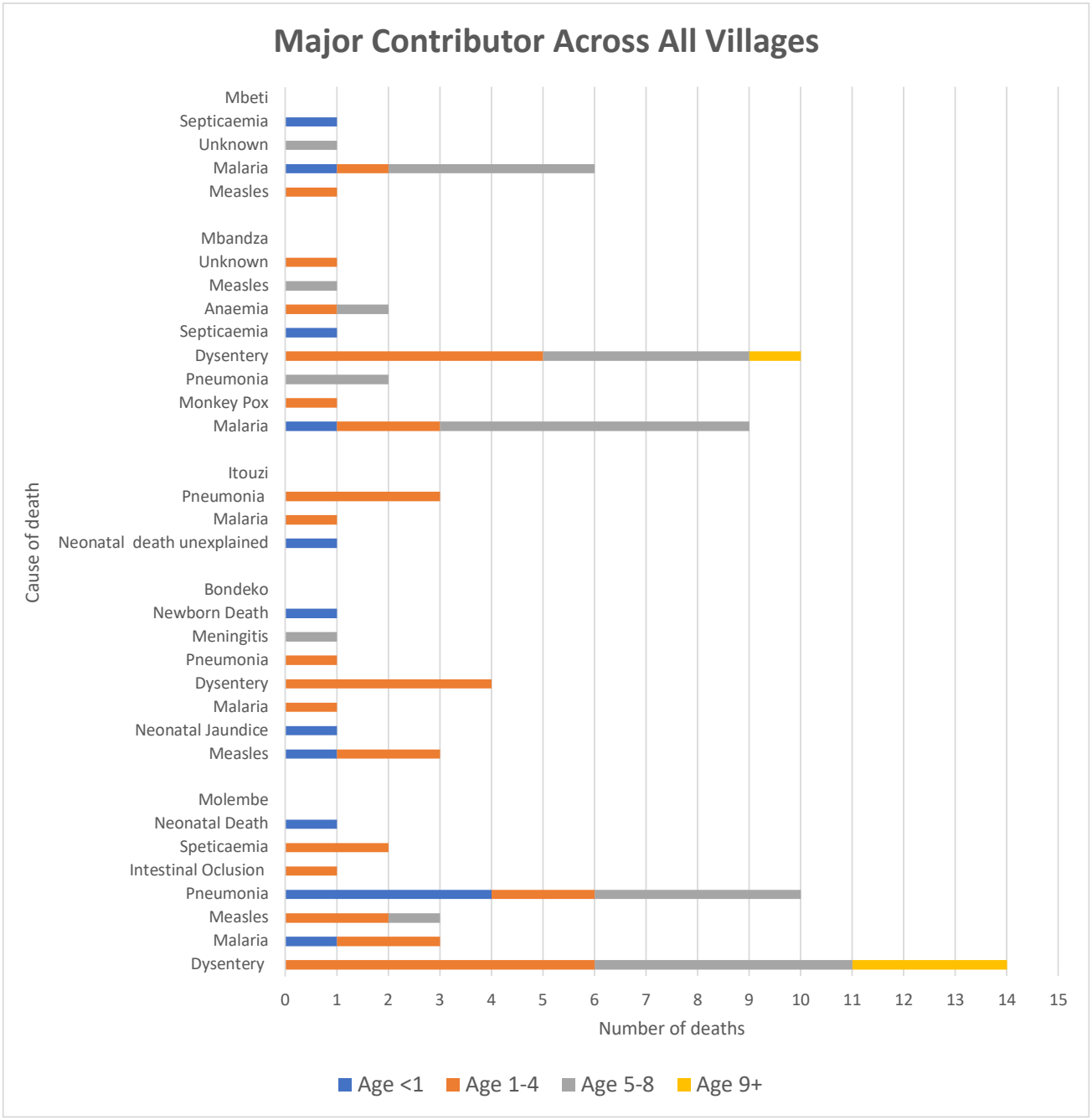
Annex 2 Graphs (continued)

Graph 4 – continued



Annex 2 Graphs (continued)

Graph 5 – Major Contributor across all villages: Probable principal cause of death



Biography of Caroline Maxwell

Caroline is an infectious and tropical disease specialist. She has over twenty years practical experience working for both the London School of Hygiene & Tropical Medicine and the Liverpool School of Tropical Medicine. During this time she has worked in Africa identifying research gaps, designing and implementing intervention trials, and applying effective use of data for planning and decision making in national policy.

Caroline worked for twelve years in Tanzania focussing primarily on research directed at optimising malaria control, evaluating novel techniques, initiating resistance monitoring of the mosquito populations, promoting the use of drug resistance monitoring to guide treatment policy, and monitoring control strategies to guide policies for optimisation of control and to ensure equity and sustainability. In Tanzania and Democratic Republic of the Congo, Caroline designed and effected training strategies in malaria diagnosis and clinical case management for capacity building of community and facility-based health care providers, and developed national quality assurance strategies. Caroline has coordinated antimalarial and antifilarial drug trials as well as studies of public/private partnerships in health care provision in Liberia to guide strategic planning and policy development. In DRC, Caroline implemented commodity management by health workers using sms messaging.

Under epidemic conditions in Sierra Leone, Caroline coordinated the implementation of a vaccine trial with a heterologous prime-boost regimen against ebola, taking responsibility for the construction of a vaccine depot and equipment store, renovation of buildings as clinics, setting up an emergency treatment room and a laboratory, ordering equipment, selection and training of staff, and coordinating an advisory group on the study protocol and ensuring documentation and collaboration with communities and MoHSW staff.

Caroline has also worked in Madagascar with the National Malaria Control Programme, in Guinea assessing risk of vector borne diseases, in Liberia conducting mosquito resistance studies and a health risk assessment of two counties.

Caroline speaks fluent Kiswahili and is professionally proficient in French, and experienced working with multiple donors; USAID, Dfid, WHO, BMGF, MRC-UK, EU.

Caroline has a B.SC. in Pharmacology and Physiology from Leeds University and a M.SC. Applied Parasitology & Medical Entomology from the Liverpool School of Tropical Medicine.

[1] Unfortunately, there were no other records available for comparing the number of deaths in 2016 to previous years.

[2] Due to a temporary illness affecting vision Caroline Maxwell was unable to complete the report in October and it was completed in February 2018.