



**Assistance Publique
Hôpitaux de Marseille**

Cholera in Haiti: Epidemic and Fight History Prospects and Recommendations

**Renaud Piarroux
Stanislas Rebaudet**

Assistance Publique-Hôpitaux de Marseille (APHM)

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Introduction

Since October 2010, Haiti has been plagued by a cholera epidemic, reaching an unprecedented scale in recent history. On 28 May 2016, the Ministry of Public Health and Population (MSPP) reported 780,140 cases and 9,317 deaths, i.e. the largest cholera epidemic in the world. While in 2014, the situation seemed to improve, opening the door to the very real prospect of elimination. Yet this year the fight has stalled and cholera rebounded. In just six months, from January to June 2016, more than 21,000 cases and 200 deaths have been recorded in Haiti and the coming rainy season, to last until November or perhaps to December, suggests the possibility of a particularly high cholera death toll this year, possibly up to 400 or 500 deaths, compared with 300, two years ago.

What are the causes of this recent failure? What is the actual progress of the action plan launched more than three years ago to move toward the elimination of cholera? And finally, how can the fight against cholera be put back on track?

The purpose of this report is to assess the cholera situation in Haiti by answering these three questions. To do this, the report starts with a historical presentation of the epidemic and the elimination plan. Then it focuses on the first steps taken to implement the plan using "cholera alerts." Centre Department provides the setting for an example of the current situation and ongoing problems. Finally based on the current situation, the report formulates and discusses a number of recommendations to guide the medium-term struggle against cholera.

Historical description of the epidemic and the national plan to fight cholera

The way cholera was introduced in Haiti largely explains the initial scale of the epidemic. Indeed, the massive contamination of the Artibonite River with a strain of *Vibrio cholerae* imported from Nepal caused the simultaneous infection of thousands of people who drank water from the Artibonite and the canals feed by the river. Within a few days, the time required for disease incubation, more than 10,000 suspected cholera cases were recorded in health facilities located along the river. This intrusion of cholera through the waters of the Artibonite was followed by an epidemic of unparalleled ferocity during the seventh pandemic, with a peak reaching 4,500 cases per day, counting only those cases that were identified in the country's health facilities. A subsequent study conducted by MSF and Epicentre showed that the true number of cases and deaths in the first epidemic phase were much higher than reported by the epidemiological surveillance system, logical since most cases were not admitted to clinics or hospitals¹. Even during the early lull phase, the daily number of reported cases never fell below 400².

As shown in Figure 1, the epidemic has taken a more conventional course since the beginning of 2012, alternating periods of lull and exacerbation depending on the seasons. The dry season at the beginning of 2012 resulted in a significant decrease of cholera incidence throughout Haiti, with apparent transmission becoming non-existent in most communes. When the rains started in May, the epidemic rebounded in various parts of the country, but the intensity of transmission was lower compared with the initial epidemic phase, not exceeding 700 cases per day during transmission peaks. At this point in 2012, the cholera epidemic exhibited a set pattern – local outbreaks associated with rains, interspersed with lulls during the dry season. Prognosticators predicted the persistence of this epidemiological profile without any trend to epidemic extinction³.

¹ Francisco J. Luquero et al., « Mortality Rates during Cholera Epidemic, Haiti, 2010–2011 », *Emerging Infectious Diseases* 22, n° 3 (mars 2016): 410– 16, doi:10.3201/eid2203.141970.

² Jean Gaudart et al., « Spatio-Temporal Dynamics of Cholera during the First Year of the Epidemic in Haiti », *PLoS Negl Trop Dis* 7, n° 4 (4 avril 2013): e2145, doi:10.1371/journal.pntd.0002145; Ezra J Barzilay et al., « Cholera Surveillance during the Haiti Epidemic - The First 2 Years », *The New England journal of medicine* 368, n° 7 (9 janvier 2013): 599– 609, doi:10.1056/NEJMoa1204927; Luquero et al., « Mortality Rates during Cholera Epidemic, Haiti, 2010–2011 ».

³ Andrea Rinaldo et al., « Reassessment of the 2010–2011 Haiti Cholera Outbreak and Rainfall-Driven Multiseason Projections », *Proceedings of the National Academy of Sciences of the United States of America* 109, n° 17 (24 avril 2012): 6602– 7, doi:10.1073/pnas.1203333109.

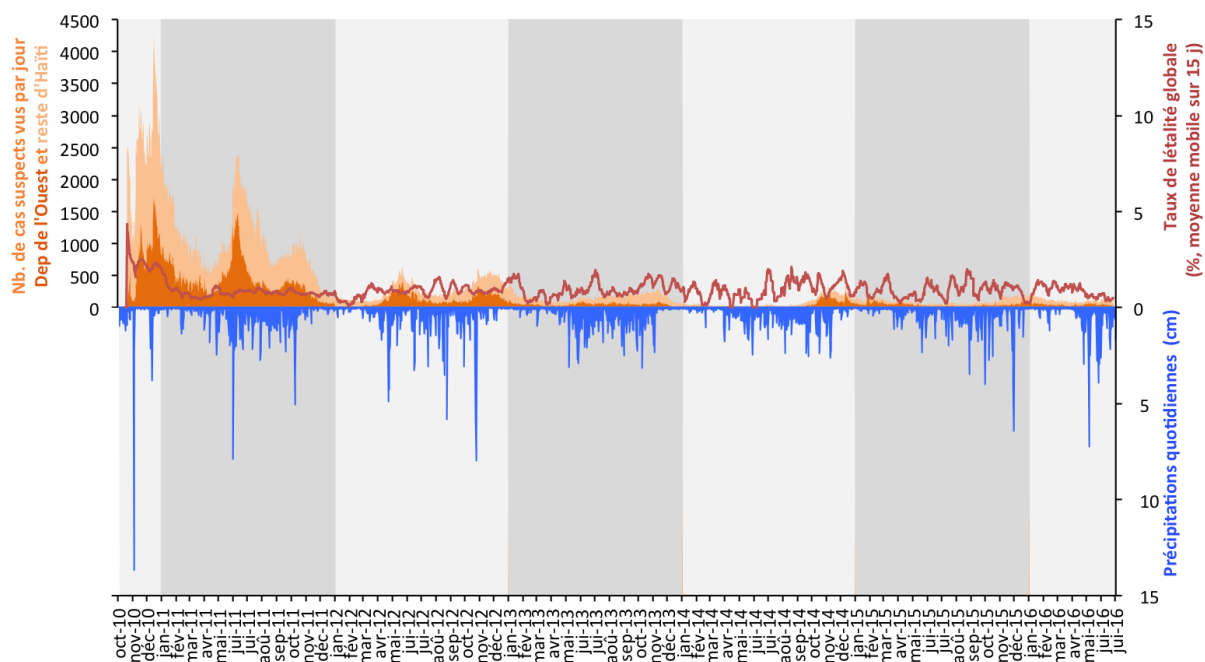


Figure 1. Temporal trend of cholera in Haiti, October 2010-June 2016.

Most important, the 2012 epidemiological data showed the situation while understandable was not acceptable. Despite the significant decline in cholera and a lull phase during the first months of 2012, over 100,000 new cases and 900 deaths were still tallied that year. Haiti, once free from cholera, seemed fated to endure endemic/epidemic cholera with a high number of cases and deaths.

Once the emergency response phase of the first two years was over, the MSPP and its partners created a plan to eliminate cholera⁴. The plan, officially launched in February 2013, focused on four components over a 10-year period from 2013 to 2022: water and sanitation; health services management and health care; epidemiology; and health promotion, hygiene and nutrition. The implementation of the plan was to occur in three phases: a short-term until December 2014, a medium term the following three years and a long-term until 2022. The cholera control and elimination strategy was presented in a 115 pages document prepared by the Ministry of Public Health and Population and the National Directorate of Water Supply and Sanitation with support from the Pan American Health Organization, UNICEF and the Centers for Disease Control and prevention of the United States. The strategic vision behind the plan was cited at the beginning of

⁴ République d'Haïti, Ministère de la Santé Publique et de la Population, et Direction Nationale de l'Eau Potable et de l'Assainissement, « Plan d'Élimination du Choléra en Haïti. 2013-2022 » (Port-au-Prince, Haïti, novembre 2012), http://www.mspp.gouv.ht/4C21F5BE-FA49-493D-847B-9191FFEAF55F/FinalDownload/DownloadId-2CB66CA71A1F98B5DC71F5C42E44E4B5/4C21F5BE-FA49-493D-847B-9191FFEAF55F/site/downloads/Plan_elimination_du_cholera_2012_2022.pdf.

the document, both in the preface, signed by the Minister of Health, and in a dedicated chapter. Without repeating too much, the plan presented cholera in Haiti as an enduring problem, or even permanent: "*The elimination of cholera from the island of Hispaniola means interrupting its transmission. However, because the bacteria are in the environment, sporadic cases will always be detected.*" The fact that the bacteria is in the environment, or more explicitly, has become a permanent host of the environment is, however, a hypothesis supported by some, denied by others, including the authors of this report. Admittedly, some strains related to the epidemic have been isolated in Haitian rivers, but this can be explained by the contamination of water with feces of patients living in the neighborhood. It does not mean that the pathogenic strain lives permanently in the environment. Once introduced into Haitian waters, the strain responsible for the epidemic is challenged by indigenous *Vibrio cholerae*, better adapted to the local environment. These indigenous strains do not synthesize cholera toxin and therefore do not lead to cholera epidemics⁵.

While the permanent presence of the strain responsible for the outbreak in Haitian waters is in disputable, it is cited in the 10-year plan as a cornerstone of its cholera control strategy. To the writers of the plan, cholera is primarily the result of social, sanitary and health conditions of the Haitian population. Evidenced by the fact that the exact origin of this cholera epidemic, yet perfectly known at the time, is not even addressed. The underlying idea is that the "true" reasons for the epidemic and its unparalleled violence in the recent history of humanity are the Haitian environment, considered optimal for the proliferation of bacteria, and the living conditions of Haitians, allowing the occurrence of repeated epidemics from an environmental reservoir.⁶ With these "true" reasons in mind, the fight against cholera can only be based on a long-term approach aiming at sustainably improve access to health care, clean water and sanitation while raising awareness of good practice hygiene. The solid waste management, although indirectly related to the problem of cholera, is among the main priorities of this plan. In such an approach, the cholera problem will only be solved by educating the population and make it access to a standard of living until the conditions for cholera transmission, considered a disease of poverty, will have disappeared. « *The plan corresponds to the Government's policy of decentralization of the public health System and its extension to the most*

⁵ Sandrine Baron et al., « No evidence of significant levels of toxigenic *V. cholerae* O1 in the Haitian aquatic environment during the 2012 rainy season », *PLoS Currents Outbreaks* 5 (2013), <http://currents.plos.org/outbreaks/article/no-evidence-of-significant-levels-of-toxigenic-v-cholerae-o1-in-the-haitian-aquatic-environment-during-the-2012-rainy-season/>; Rebaudet, Stanislas et Piarroux, Renaud, « Uncertain cholera environmental reservoir in Haiti », *Emerging Infectious Diseases* ahead of print (2014).

⁶ Alejandro Cravioto et al., « Final Report of the Independent Panel of Experts on the Cholera Outbreak in Haiti » (New York, NY: United Nations, mai 2011), <http://www.un.org/News/dh/infocus/haiti/UN-cholera-report-final.pdf>. A l'inverse, le grand historien haïtien Thomas Madiou, surpris que le cholera ne soit jamais parvenu en Haïti alors que le reste de la Caraïbe avait été durement touché, ne se demandait-il pas en 1843 dans son Histoire d'Haïti si « *cela [tiendrait] aux émanations de notre sol qui ne permettraient pas d'exister aux animalcules cholériques ou à un état particulier de notre atmosphère* »⁶ ?

remote population areas. The objective is for the entire population to have access to a health post within a reasonable distance. The Plan of Action Proposes to put in place health structures to reduce the incidence of cholera, to improve water supply and sanitation coverage, improve health coverage, and promote greater awareness among the population about the importance of better services impacting health (i.e. primary health care, solid waste management, water supply and sanitation facilities, etc.) ». If everyone has access to safe drinking water, toilets and good access to care, and if otherwise, everyone strictly applies the good hygiene practices, cholera problem will be resolved. This is true, but at best, it will take decades to get there. By then, how many new cases and deaths will occur?

Fortunately, the experience of many countries shows that the fight against cholera as a single disease rather than a social construct, can lead to the complete elimination of the disease, even in developing countries. This was the case in Madagascar and West African countries, from Ghana to Mauritania. Even in the Lake Chad Basin, a particularly challenging area to tackle cholera because of the insecure context in northern Nigeria and bordering countries, the situation largely improved this year. Why would what was possible in Madagascar and West Africa not be feasible in Haiti?

Finally, the cholera elimination plan in Haiti mainly offers the appearance of a development plan aiming at improving the overall public health in Haiti as part of an integrated approach. As such, the reading of the plan's objectives is uplifting.

« In order to prevent deaths and reduce the suffering caused by the Cholera epidemic, the Haitian government's main strategy is to put in place an integrated approach to prevent and stop the secondary transmission of cholera in Haiti.

From this perspective, the Haitian government has established the following specific objectives to be attained over the next 10 years, that is, by 2022:

- 1 . Increase access to potable water to at least 85% of the population;*
- 2 . Increase access to improved sanitary and hygiene facilities to at least 90% of the population;*
- 3. Increase collection of solid waste in the metropolitan area of Port au Prince to 90% and in secondary cities to 80%;*
- 4. Strengthen the public health system to facilitate access to health care services for 80% of the population by increasing the number of physicians and nurses per 100,000 population;*

5. Strengthen epidemiological and laboratory surveillance for early detection of all cholera cases and other diseases under surveillance. This will be achieved through an integrated surveillance system, better information, feedback, an information administration, and regulations for communications;

6. Ensure research on outbreaks and a response linked to surveillance activities;

7. Ensure a strong laboratory surveillance component to examine the possible serotypes and genotypes, as well as eventual changes in antimicrobial resistance among Vibrio cholerae strains in Haiti;

8. Intensify education of the public about household hygiene and food hygiene to the extent that by 2022, 75% of the general population in Haiti will have knowledge of prevention measures for cholera and other diarrheal illnesses;

9. Put in place an evaluation tool to measure the impact of activities related to cholera, water borne diseases, and, more broadly, socioeconomic indicators such as absenteeism from schools and workplaces. »

On reading these objectives, it is clear that the approach advocated by the plan positions is very long term and aims at the overall development of Haiti. Most of the goals will not be achieved for decades, except for epidemiological surveillance (considered here as integrated monitoring of all diseases under surveillance) and investigation/outbreak response. Given that epidemiological surveillance makes sense only if it is followed by investigations that guides outbreak response, the goal number 6 of the plan « *Ensure research on outbreaks and a response linked to surveillance activities* » is the only one which will ensure the success, or failure, of the struggle during the long years necessary to achieve significant progress in other sectors. Unfortunately, the strategic importance of this point was not seen during the writing of the action plan, as reflected in the initial budget for this activity (one million dollars over ten years, i.e. 0.04% of the elimination plan total budget). This amount should be compared, for example, to the 370 million required for the collection of solid waste.

The Alert/Response strategy was not explicitly stated in the elimination plan, at least not in the current form. Unlike other activities in the plan, the component Alert/Response focuses strictly on cholera and aims to reduce the burden of the disease wherever cases are detected. It is therefore based on specific mechanisms for case detection and targeted response, to intervene in the communities and neighborhoods affected within less than 48 hours after the hospitalization of a suspected case. Once cholera is in the area, rapid response teams, from either the Department (Equipes Mobiles d'Intervention Rapide, EMIRA) as well as teams supported by NGOs, should

investigate the causes of local cholera, improve population awareness, search for possible new suspected cases in the community and help the local population to protect its drinking water by providing chlorine tablets and by establishing chlorination points on unprotected water sources. This strategy, which we had advocated following the various studies on the Haiti cholera epidemic ⁷ was progressively started from July 2013, benefiting first from UNICEF funding (reallocation of funds available locally) then from various donors funding (see details below).

Epidemic evolution after starting Alert/Response approach

The Alert/Response approach quickly had an impact on the epidemic. At the end of 2013, barely a few months after the beginning of its implementation, it became clear that the dynamics of the epidemic evolved more favorably than expected, even in the most optimistic forecasts that expected a year-end peak of about 3000 cases per week ⁸. The epidemic peak, which occurred in November 2013, was lower than the previous year (1,802 cases during Nov. 11-17 vs. 3,419 cases in previous year at peak during Oct. 3 - Nov. 5). Also notable was the epidemic lull phase that followed the end of the rainy season, much more pronounced than in previous years. At the end of 2013, the incidence of cholera was only 50 cases per day. The improving trend was accentuated during the first half of 2014 and the number of cases has stabilized for more than six months around 200 to 250 per week. Taking into account that the microbiological data showed that only a quarter of the analyzed stool specimens were actually positive (others were non-cholera diarrhea), the actual incidence of cholera at the end of 2013 decreased to 10 cases per day. If at that time, especially in April-June 2014, efforts had been concentrated on extinguishing the last outbreaks, cholera could have been removed from Haiti, as it was in Sierra Leone, Guinea and Guinea Bissau after the 2012 epidemic wave, or in Ghana and Côte d'Ivoire after the 2014 outbreak. Each of these five countries, and the countries around them, is currently experiencing a lull period, with no confirmed case of cholera in 2015 and in the first half 2016.

⁷ Renaud Piarroux et al., « Understanding the cholera epidemic, Haiti », *Emerging Infectious Diseases* 17, n° 7 (juillet 2011): 1161- 68, doi:10.3201/eid1707.110059; Jean Gaudart et al., « Spatio-Temporal Dynamics of Cholera during the First Year of the Epidemic in Haiti », *PLoS Negl Trop Dis* 7, n° 4 (4 avril 2013): e2145, doi:10.1371/journal.pntd.0002145; Stanislas Rebaudet et al., « The dry season in Haiti: a window of opportunity to eliminate cholera », *PLoS Currents Outbreaks* 5 (10 juin 2013), doi: ecurrents.outbreaks.2193a0ec4401d9526203af12e5024ddc.

10.1371/currents.outbreaks.2193a0ec4401d9526203af12e5024ddc; Baron et al., « No evidence of significant levels of toxigenic *V. cholerae* O1 in the Haitian aquatic environment during the 2012 rainy season ».

⁸ Enrico Bertuzzo et al., « On the Probability of Extinction of the Haiti Cholera Epidemic », *Stochastic Environmental Research and Risk Assessment*, 7 juin 2014, 1- 13, doi:10.1007/s00477-014-0906-3.

Alas, the end of 2014 marked a breakpoint in this positive evolution, first with an outbreak of cholera in northern Artibonite at the end of June linked to poor health management of a religious feast, and above all, by the rebound of the epidemic in the greater Port-au-Prince in September (Figure 2). This rebound was not detected in time due to a failure of epidemiological surveillance in the Port au Prince area (health care facilities that treated the case for several weeks at Corail and at Cité Soleil, did not report the event to the departmental health authorities). When the problem was finally detected in late October, cholera had already spread to other districts. The situation became further complicated by acts of vandalism on the water network of the southern neighborhoods of greater Port au Prince. In particular, a main pipe network was severely damaged by gangs engaged in the trade of water. The gangsters, instead of selling water from catchment sources, willfully damage the mains water network and then pumped water into trucks for delivery to other neighborhoods. In Port au Prince, the Route des Dalles, passing over a main pipe became the place of a permanent truck traffic, filling their tanks with water from the vandalized pipeline. For various reasons, no one opposed it, neither the Haitian police nor the soldiers of MINUSTAH (United Nations Stabilization Mission in Haiti).

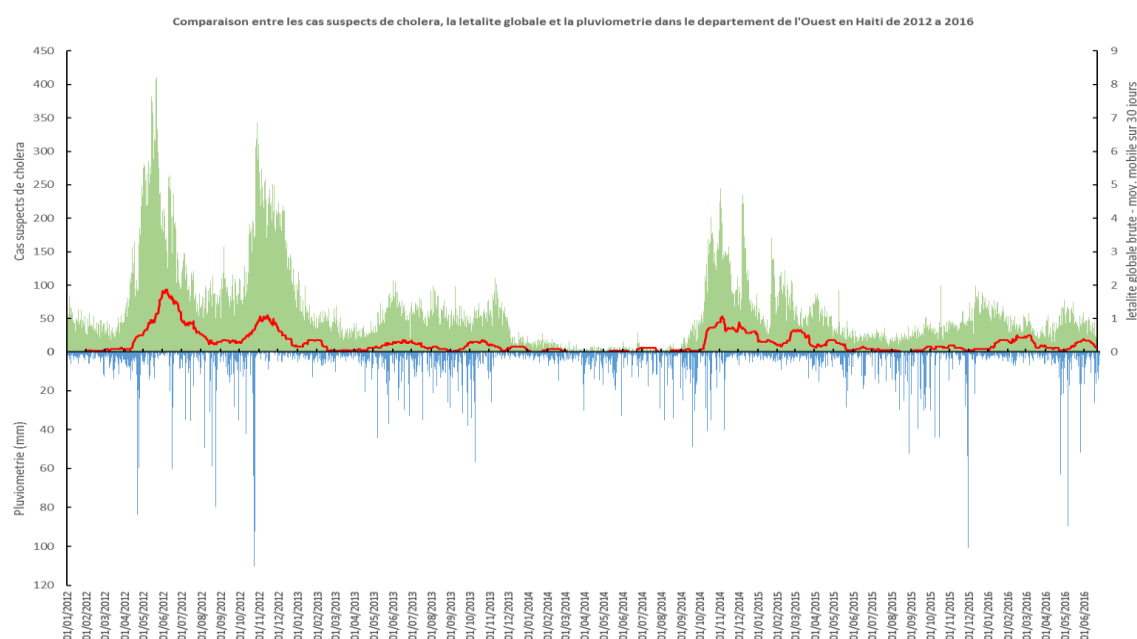


Figure 2. Suspected cases, cholera lethality and rainfall in West Department, January 2012- June 2016).

When cholera returned to the south area of Port au Prince, the health consequences of the pipeline vandalism were considerable. Runoff water from neighborhoods over the Route des Dalles mixed with water from the damaged pipes then was consumed by the inhabitants of the neighborhoods served by the network, causing a succession of severe cholera outbreaks. A large market was in the same area, drawing people for food and water (by now contaminated) before traveling to distant places. Cholera then spread along the roads to areas throughout the country.

To have quickly remedied the situation, a significant mobilization would have been required with police intervention, the water services, public works and health services. We personally advocated for such mobilization at the highest level (Prime Minister, Minister of Health, Representative in Haiti of the UN Secretary General) during a mission in January 2015, just after a cholera peak caused by a new episode of water pipe contamination. However, the response was inadequate and we had to cope with limited resources, deploying and organizing humanitarian teams, to chlorinate pipe water sold in kiosks and stored at home. Since then, some repairs were made, but the trafficking of water by gangs persists, as well as the contamination it causes. Nevertheless, thanks to the establishment of many points of chlorination by NGOs, cholera outbreaks in southern Port-au-Prince have gradually dried up during the first quarter of 2015.

Despite the return of the rainy season in the months that followed, the situation improved at the national level. However, the number of cases never dropped as low as the lull period of the previous year, and a rebound of cholera was recorded in late 2015 when there was political turmoil that accompanied the campaign for parliamentary and presidential elections. The election period hindered the mobilization of state health teams and NGO interventions. It also opened the door to further acts of vandalism, marking the wrath of one political camp or another. These acts of vandalism have resulted in water network destruction and cholera outbreaks in Pilate and Plaisance, two towns in the Nord Department already identified as highly vulnerable to cholera (Figure 3). Although these outbreaks have caused deaths and have allowed cholera to spread again in the north of the country, no one seemed to be alarmed.

These acts of vandalism and the minimal institutional response to protect water distribution infrastructure contributed significantly to the expansion of cholera in Haiti. Yet so far waves of large outbreaks were avoided, due to the implementation of mobile teams Alert/Response component of the cholera plan, far different from the first two years of the epidemic.

Unfortunately the situation is deteriorating, due to the drastic reduction of funds available to finance the response to alerts. At the time of writing this report, and until the end of the year, secured funds for 2016 represents \$4.9 million. Half of the funds are humanitarian aid from the European Union

(ECHO \$2.4 million) and the rest are from Great Britain (DFID, \$1.1 million), Norway (\$800,000), Canada (\$200,000) and UNICEF (\$400,000). Additionally, some funding comes from the World Bank to pay part of EMIRA. For 2017, the situation looks grim. DFID funded by Great Britain has decided to withdraw while the World Bank could possibly do the same. ECHO from the European Union, which is the main donor for this program, is increasingly reluctant to raise new funds for humanitarian aid, considering that the fight against cholera should now be in a development process. Yet the estimated \$2.2 billion required to finance the main plan over ten years is far short of its goal.

The cholera epidemic is a crisis that has outlasted the patience of donor agencies. In this respect, it is noteworthy that neither the United Nations, which had originally contributed to the Alert/Response approach via various emergency funding (CERF funds of \$3.34 million in January 2014 and \$2.35 million in July 2015, all spent) nor US donors, who have never supported the strategy for responding to alerts, are currently providing assistance to sustain the rapid response activities. Yet in the absence of significant progress in the other major components of the elimination plan, it is still the only measure that allowed lives to be saved by controlling outbreaks. Finally, due to the increased death toll, new emergency funding is being requested from the United Nations. But will this request be granted? Will the program be properly implemented or will humanitarian assistance be withheld until the cholera situation is again catastrophic before reluctantly garnering sufficient funds?

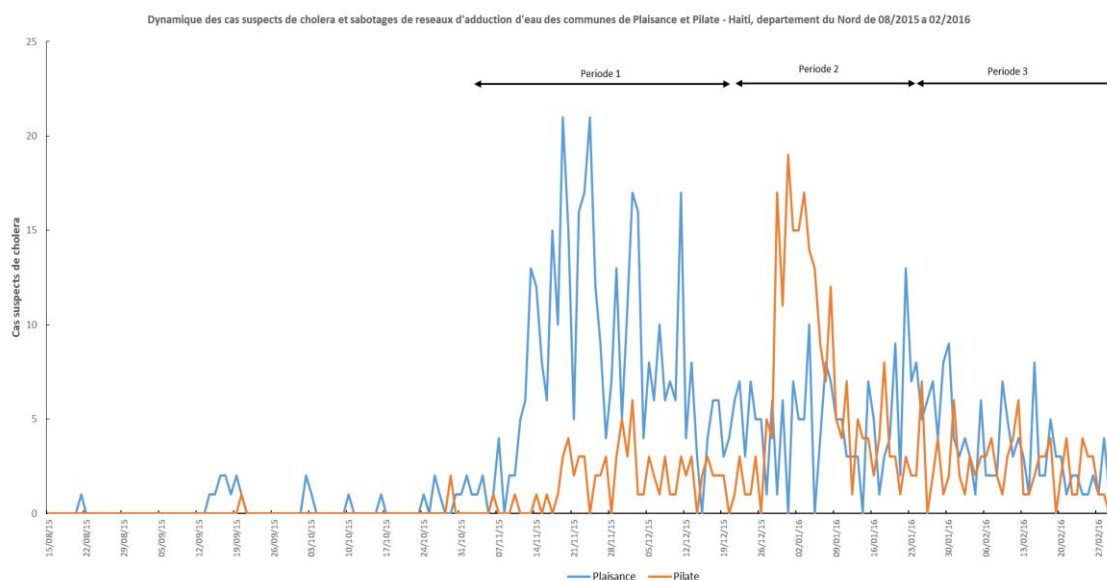


Figure 3 : Suspected cholera cases and vandalism on water pipes in Pilate and Plaisance North Department (Haiti August 2015 to February 2016)

Period 1 : In the period late October / early November, a first act of sabotage took place in the town of Plaisance (Nan Clair and Gobert localities) immediately interrupting the water supply of all places between the downtowns of Plaisance and Pilate. The community was then forced to draw water in the few water points that will be quickly contaminated by cholera. It follows an epidemic outbreak first visible in the town of Plaisance with a daily transmission average equal to 10 cases / day over the period from 10 November to 10 December 2015. Over the same period, we also note an extension of the epidemic in the municipality of Pilate, nevertheless under control. On the two municipalities, community responses activities of the various partners, although not optimal, were possible despite high tension due to the protest against local elections results. With the optimization of the response reinforced by two rapid response teams (mixed), a decrease in transmission is noticed until December 27.

Period 2 : Two successive sabotage in two-day interval were reported by Pilate hospital. The city center and the hospital itself were no longer supplied by the pipe networks. At the same time the security context rapidly degraded with three murders recorded by the police. The response teams could only come when the police was present, and could not avoid a second epidemic outbreak. The transmission was higher in Pilate than in Plaisance where the community response was still possible.

Period 3 : A stabilization of the security situation was obtained after negotiating with the political parties and a joint advocacy work. The majority of the response effort targeted the town of Pilate where a significant drop in cases was recorded. Trade flows also resume their course. With an obligatory passage at Plaisance for Pilate inhabitants, a slight increase was seen in Plaisance.

The Alert/Response activities, originally intended as a complementary approach to the elimination plan for limiting the impact of the epidemic while awaiting the positive effects of infrastructure works, became by force of circumstances, the main defense line of the Haitian people against cholera. This Alert/Response approach had the advantage of costing much less than development activities. Yet for lack of sufficient funds, other aspects of the fight against cholera, which could reduce the vulnerability of the Haitian people to cholera, have not progressed.

We sought for indicators that show the evolution of access to clean water during the first three years of the cholera elimination plan (Goal: increase access to safe water to at least 85% of the population). We were told that this indicator was not available and that ONEPA (National observatory of drinking water and sanitation) – the agency that could have collected the necessary data – had no dedicated staff and have no plans to hire such staff in the immediate future. In addition, five years after the start of the epidemic, there is still no external monitoring of water quality, only the company that produces the water makes its own determinations of free residual chlorine to manage its chlorination. On several occasions, it was noted the absence of residual chlorine and the presence of fecal bacteria in water systems during outbreak investigations. Considering the management of suspected cholera cases, many teams working on the ground repeatedly reported catastrophic conditions for patients' care in different health centers. In numbers of cases, it was necessary to require intervention of the medical EMIRA staff to ensure acceptable management of patients, although they originally were recruited to fight against cholera transmission in the community. Examples could be multiplied at will, on the various aspects of the fight that were never implemented, but it is not the purpose of this report to make an overall assessment of the national plan for cholera elimination. Let us simply note that three years after the publication of this plan, we see no significant progress regarding the vulnerability of the Haitian people to cholera.

The outbreak in Centre department

The current epidemiological situation of cholera in Haiti is characterized by a relative calm in most of the territory except in the Centre Department and in some neighboring communes in the Artibonite and West departments, where outbreaks are spreading. Studying why cholera could spread in Centre department and analyzing the response is useful to better understand the current context of the fight against cholera in Haiti. Therefore, we present here a detailed account of the situation that we were able to evaluate during a field visit in July 2016.

The situation in most towns of the Centre was quiet at the beginning of the year (Figure 4). However, there was a focus in Mirebalais that persisted in the form of a succession of outbreaks separated by partial lulls. This focus mainly concerned the semi-rural neighborhoods on the outskirts of the city, especially in the 2nd communal section Sarazin, along the road between Mirebalais and Lascahobas (Figure 5). These neighborhoods are not served by the water system of Mirebalais. There are some hand pumps, but many people are forced to draw water at unprotected sources or along the river Fer-à-Cheval. Note that the people of the 2nd communal section Sarazin were targeted by a vaccination campaign in 2014. Over time Mirebalais' cholera focus has grown and spread eastward to the nearby town of Lascahobas (also targeted by the 2014 vaccination campaign) then Belladères, and west on the commune of Boucan Carré.

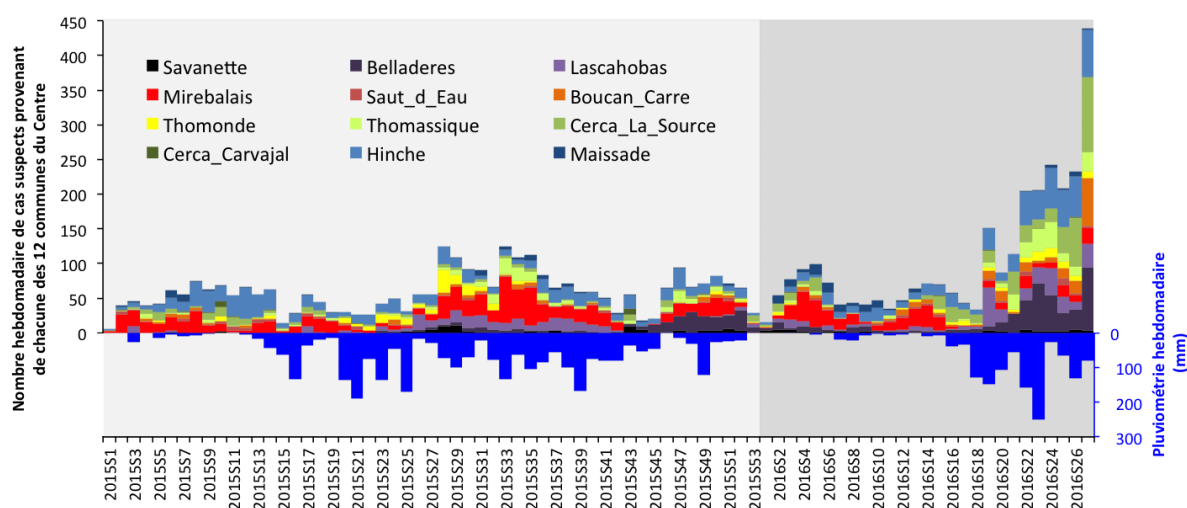


Figure 4 : Weekly evolution of suspected cases number in the commune of Centre Department from January 2015 to June 2016.

(Source : linelisting of DSC; rainfall in Centre department, NASA)

Choléra dans le département du Centre (DSC) en 2016

(source: linelisting DSC)

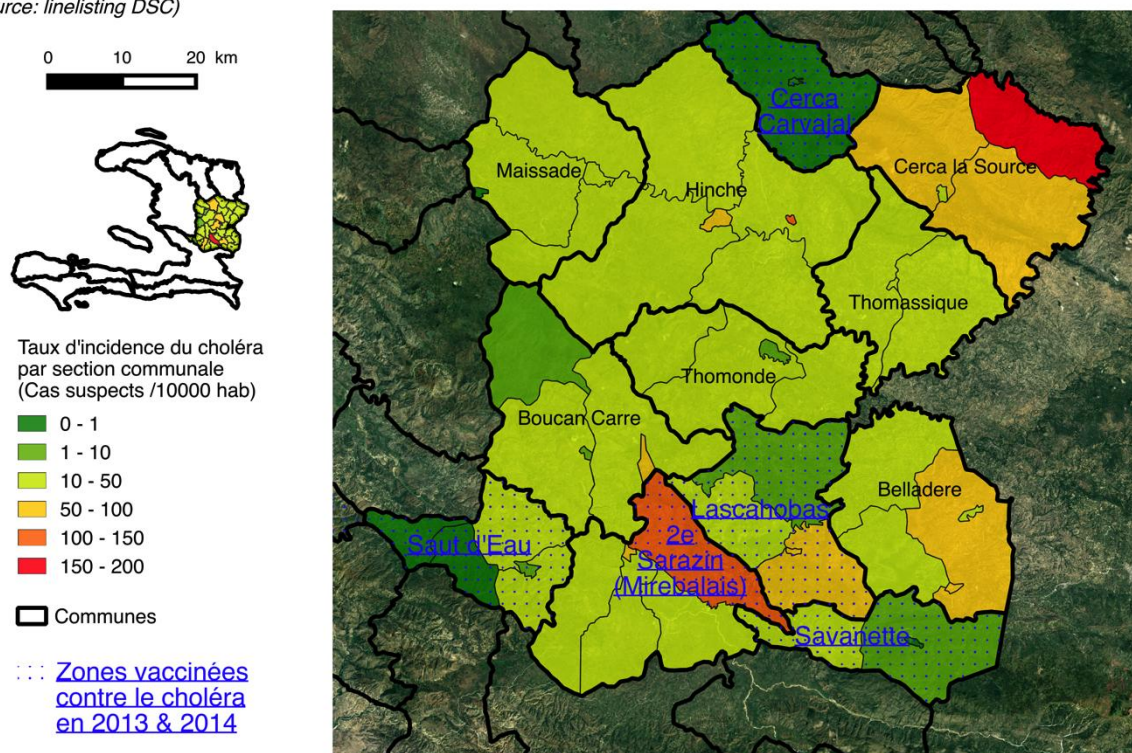


Figure 5 : Cholera incidence by communal section, Centre Department, January-December 2016, and areas vaccinated against cholera in 2013 and 2014.

(Source : linelisting of DSC)

North of the department, the situation was a little calmer until April, even if one could note some suspected cholera cases in Hinche treatment center and in the town of Maïssade. Transmission has intensified since April, and new foci occurred in the adjacent municipalities, starting with Cerca-la-Source, and then Thomassique and Thomonde (Figure 5). In these towns, cholera affected mainly peripheral localities, including the 3rd Lamielle section of Cerca-la-Source, where people live without access to clean water. Despite their small size, some of these communities, composed of a few dozen houses more or less dispersed, could count dozens of cases, showing how cholera could still wreak havoc despite the fact that the disease is circulating in the country since more than five years. The main towns, in contrast, generally remained unaffected (Figure 5), probably because the quality of drinking water is better there. Note, however, that in the small water systems of these towns, the water is not chlorinated.

Rapid responses were unfortunately not effective enough to control these outbreaks before cases could scattered. Only 3 mobile EMIRA/NGO teams were operational during the first weeks of the outbreak. Thus, despite the dry season, cholera has persisted for months in Mirebalais, Hinche and

Lascahobas, facilitating the dispersion of foci during the return of the rainy season. This inefficiency can be attributed to the lack of available teams and vehicles to cover the whole area. Leasing additional vehicles to form mixed teams EMIRA/NGO, came too late at a time when the number of active centers renders illusory any hope of controlling transmission in all areas simultaneously. Besides the lack of vehicles and field teams, response activities were undersized compared to the needs. Field interventions were made in too small perimeter around the homes of patients and the amount of distributed chlorine tablets to treat water at home was only enough to cover at best, fifteen days. Lacking of funding, and also lacking of supervision and training, the too few and poorly equipped teams have not been able to contain outbreaks at their start and have not adapted their procedure to the evolution of the situation. Now they run after outbreaks without being able to prevent their dissemination. To take control of the situation, we must deploy many more people, targeting wider intervention areas to educate more people and distribute more soap and chlorine products. While these outbreaks are predominantly rural, it is also necessary to be very vigilant in urban areas and do everything possible to ensure chlorination of pipe networks. Indeed, with the exception of Hinche and Mirebalais (and still, inconstantly) they were not treated. Again, five years into the epidemic, we wonder why it has not been possible to better protect people by chlorinating water in towns and cities.

Finally, around 4,000 suspected cholera cases have been notified by the health institutions of the Centre Department.

Recommendations and discussion

1. Reinforce immediately the Alert/Response by doubling the number of teams in the field and increasing their inputs.

The Alert/Response is the first and main approach to prevent outbreaks of importance in a context where the vulnerability of the Haitian population is identical to which prevailed at the beginning of the epidemic. In 2014, we did not go far enough for the cholera transmission to be completely stopped and thus, for cholera to be eliminated. Unfortunately, since then, the necessary funds fell drastically and cholera rebounded. There are currently 30 NGO teams and 12 EMIRA teams on the field. Given the current situation, it would require twice this number of teams to avoid seeing cholera spreading in the ten departments of the country.

2. Secure the budget of these teams to provide a medium-term visibility.

Whether they are EMIRA or mobile teams of NGOs, field teams must be recruited, trained, equipped and supervised before becoming fully operational. Piecemeal planning due to the lack of funding has led to programs interruptions harmful for both mobile team members and the quality of their work as well as for expatriate NGO team responsible for the frame. Moreover, stable funding would alleviate the problem of sometimes extremely long period of payment of EMIRA (in some cases delayed payments exceeded ten months, affecting work efficiency and giving a bad image of the donors).

3. Strengthen the training, supervision and versatility (WASH/Health) of the teams in the Alert/Response activities.

The quality of work of field teams remained uneven, depending on their level of training and the rigor of their supervision. By stabilizing these teams, it will be possible to invest more in training and improve the quality of response. In addition, it would be desirable to provide better flexibility to field teams combining the WASH skills of NGO and the medical skills of EMIRA (EMIRA are the only teams entitled to supply care about any patients identified in the field and to deliver doxycycline to people in direct contact with patients).

4. Implement a series of small projects aiming to improve access to clean water, guided by the results of investigations conducted in response to alerts.

Initially, the Alert/Response approach foresaw the realization of small projects in securing water resources identified as likely contaminated by the investigation mobile teams. This very

pragmatic approach was rapidly abandoned for lack of sufficient funding for implementation. Therefore, cholera was able to resurface every year in the same localities and for the same reasons. Note that works of this type are conducted by MINUSTAH but without any coordination with the fight against cholera. As a result, the vast majority of MINUSTAH projects are performed outside the priority areas affected by cholera – not beneficial to the elimination efforts.

5. Orient large project for sustainable improvement of drinking water quality to the areas already identified as at high risk of cholera.

In parallel with Alert/Response and through high accuracy epidemiological data that this approach has raised, a precise mapping of the most commonly affected urban areas is in progress. Such knowledge of areas at risk of cholera in urban areas is expected to orientate the work needed to improve access to safe drinking water by prioritizing the most frequently areas hit by cholera outbreaks. The cost of this work will be considerable, but how can we expect sustainable results without addressing the situation of urban cholera? We must stop delaying this aspect of the struggle by turning always to rural areas or small towns, simply because it is easier and faster. Cholera must be fought wherever it occurs, not only where it seems easier to fight.

6. Reinforce epidemiological surveillance and better adapt it to the fight against cholera.

The epidemiological surveillance process aims primarily to provide decision makers with the information necessary for the organization of the fight against diseases. Regarding the Alert/Response, the approach uses speed and accuracy to locate the source of cholera for intervention before the disease has aggressively spread. Therefore, monitoring has to be adapted by adding a fast loop, managed locally, allowing field teams to get in real time, the listing of areas from which the patients are coming. Thus, the database of suspected cases per day per municipality, organized by place of treatment of patients, now adds another element locating the source of the patient with the greatest possible precision. Such a database expansion opens the door to extremely fine epidemiological analyzes in both urban and rural areas. These analyzes can then be used to better understand the local dynamics of the epidemic and to prioritize activities to be implemented to prevent recurrence. It is therefore a specifically targeted surveillance that cannot be built entirely in the epidemiological surveillance routine.

7. Improve the management of cases by providing a pool of specialized caregivers in the treatment of cholera to strengthen ailing health structures or to create de novo when and where the need arises.

The departure of the NGOs at the end of the extreme emergency phase left a very unbalanced situation regarding the quality of care for patients with cholera. Some cholera treatment centers have become a humanitarian showcase even up the construction of award winning futuristic buildings in architectural competitions (Treatment Center Gheskio http://www.world-architects.com/en/projects/48350_GHESKIO_Cholera_Treatment_Center), others, by contrast, are infamous death houses where the sick are left to the care of their relatives without any measure taken to prevent the spread of germs between patients and visitors. There are even cases where access to care was denied to patients with suspected cholera on the pretext that the caregiver had other things to do and was not paid to take care of cholera patients. The creation of a pool of caregivers can be made to strengthen the medical staff of a clinic overwhelmed by an influx of patients. Such a group would improve the prognosis of the disease in the less well-supported centers and reduce hospital transmission of the disease, with the observance of basic hygiene measures.

8. Improve the management and security of funerals in the community to prevent outbreaks related to funerary practices.

After contamination of drinking water, funeral rites are one of the most common causes of cholera outbreaks. Awareness messages were probably distributed, especially during the most acute phase of the epidemic, but were no doubt forgotten by many families who take major risks during funeral ceremonies to show their affection for the deceased. Without questioning these ceremonies, it is essential to secure the rituals that accompany them. To do this more collaboration should be done with priests, pastors, hougans and any other person familiar with funeral rituals to define consensually messages to the population and assess the best channels to disseminate them in order to limit the risk of spreading cholera at funerals.

9. Integrally review the approach to ensure microbiological diagnosis and rendering results under 48 hours, including travel time for specimens.

For each hospitalized patient, considerable energy is devoted to the fielding of a team going to fight against cholera in an affected locality. This energy is wasted when dealing with cases of diarrhea not caused by cholera. Unfortunately, even with the best intentions, the current diagnostic process often requires weeks to deliver and analyze stool specimen. This period is too long and the use of rapid diagnostic tests had been advocated for some time, but was held back by inadequate validity of the tests. Cholera elimination plan was supposed to improve the microbiological diagnosis of cholera, particularly by increasing the number of laboratories able to carry out this diagnosis but this component has never been implemented. With the arrival of new

technologies such as mass spectrometry, it is possible to identify extemporaneously bacterial colonies obtained after 24 hours of culture. If parallel routing of samples and the organization of work in microbiology laboratories are optimized, the target of a result made available in less than 48 hours is achievable, facilitating the integration of microbiological results in the decision to intervene on a newly detected cholera outbreak. The investments required for the implementation of this new diagnostic approach would be quickly recouped by the savings made by better targeting the community responses.

10. Objectively evaluate the impact that the first campaigns of vaccination against cholera before launching new campaigns. If new campaigns are planned, a priori definition of the evaluation strategy is needed.

The results of controlled studies to measure the efficacy of oral vaccines against cholera showed efficacy around 57-65% which appears to be continuing over five years⁹. But field results may be worse if vaccines have been stored or transported in adverse conditions. Furthermore, the impact of a vaccination campaign depends on many other factors such as the number of subjects who escaped the first or the second dose or having spat out the oral vaccine. Conversely, effectiveness could be significantly improved in immunologically naïve populations against cholera, which is not the case of the Haitian population. In the end, the protected population may be a minority in a community considered fully vaccinated and with time, the mixing of populations can significantly accentuate this phenomenon. It is therefore important to evaluate, as best as possible, the actual impact of vaccinations that have already taken place in Haiti. This is all the more necessary now that the epidemiological surveillance has showed the occurrence of epidemic outbreaks in virtually all areas that have been vaccinated so far (see Figure 6, the example of Petite Anse neighborhood in Cap Haïtien).

⁹ David Sinclair et al., « Oral vaccines for preventing cholera », *Cochrane Database of Systematic Reviews (Online)*, n° 3 (2011): CD008603, doi:10.1002/14651858.CD008603.pub2; Sujit K Bhattacharya et al., « 5 Year Efficacy of a Bivalent Killed Whole-Cell Oral Cholera Vaccine in Kolkata, India: A Cluster-Randomised, Double-Blind, Placebo-Controlled Trial », *The Lancet Infectious Diseases*, 17 octobre 2013, doi:10.1016/S1473-3099(13)70273-1.

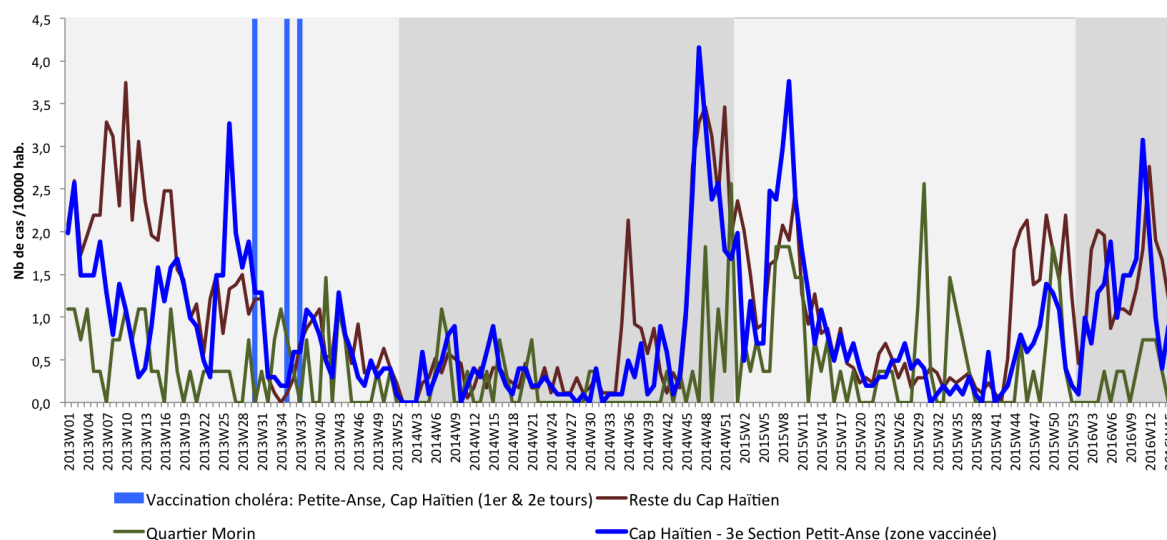


Figure 6. Weekly incidence of suspected cholera cases in Petite-Anse (subjected to vaccination campaign in August and September 2013) compared to the rest of Cap Haitian and Quartier Morin, from January 2013 to April 2016.

(Source : HUI, Cap-Haïtien and CTC Bravo, Quartier Morin).

Conclusion

Almost six years after the beginning of the cholera epidemic and more than three years after the launch of a national plan for cholera elimination that has never received appropriate funding, the vulnerability of Haitian population has not decrease. Instead, this vulnerability is probably going to increase as natural immunity fades, conferred by the epidemic waves of 2010-11. The Alert/Response approach, which initially led to spectacular results giving hope for a rapid elimination of cholera is now deadlocked: major infrastructure at the water network problems raised by epidemiological studies were never seriously tackled, nor the security problems raised by field teams facing gangs and angry populations. No real mobilization occurred to support the field teams chasing the epidemic starts to limit the spread. Neither local politicians nor the international community seem to have taken the measure of the seriousness of the situation.

Haiti's cholera outbreak is, by the number of cases, the largest epidemic the world has faced in the last decades. Taking into account the latest mortality estimates in the initial phase, it even exceeds mortality in the Ebola epidemic in 2013-2014. That the current response is not up to the challenge is an understatement. With the lack of funding, even the emergency component of the Alert/Response strategy has gradually disintegrated, first with the abandonment of water security in areas affected by cholera, then with the reduction of teams and means available to secure drinking water during outbreaks. In this context of funding shortfall, vaccination campaigns, too limited in scope to have any impact on the dynamics of the epidemic, are in direct competition with available funds to respond to outbreaks. Competition between teams fighting cholera would not be bad if each activity was properly funded. The cholera epidemic in Haiti has now been studied from all angles; the circumstances of occurrence and modes of propagation are well known as well as the main vulnerable areas and activities that should be implemented to stop it permanently. What is missing to win this battle is essential: substantial and sustainable funding, mobilization of stakeholders at all levels, and political will to end this disaster.