ITU Publications

International Telecommunication Union
Development Sector

Telecommunication networks and infrastructure resilience assessment in Haiti

Telecommunications networks and infrastructures resilience assessment in Haiti

Acknowledgements

This report was prepared by Mr. Gregory Domond under the direction of the International Telecommunication Union (ITU) Telecommunication Development Bureau (BDT) Connect2Recover initiative and the ITU Area Office for the Caribbean in close coordination with the ITU BDT Environment and Emergency Telecommunications Division.

ITU would like to thank Mr. Jean Marie Guillaume, Director-General of CONATEL, for his invaluable support. In addition, ITU would like to thank Mr. Max Larson Henry, current President of Haiti association for the development of ICTs (AHTIC), Mr. Reynold Guerrier, former President of AHTIC and CEO of IT and Statistics Support Group (GSIS), Mr. Fritz Joassin, Chairman and CEO of Electrocom S.A. et Satelcom Haïti Wireless, and Mr. Yvon Auguste, Technical Director of National Television of Haiti.

Disclaimers

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by ITU in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by ITU to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader.

ISBN

978-92-61-38011-3 (Electronic version)
978-92-61-38021-2 (EPUB version)
978-92-61-38031-1 (MOBI version)

Please consider the environment before printing this report.

Foreword

I am pleased to present a comprehensive report on Telecommunications networks and infrastructures resilience assessment in Haiti. This report was crafted with the valuable collaboration and support of Conseil National des Telecommunications (CONATEL). Its significance extends beyond the borders of Haiti as it has the potential to serve as a valuable resource for Least Developed Countries (LDCs) and Small Island Developing States (SIDS) in enhancing the resilience of their digital infrastructure against the threats posed by natural hazards.

Disasters have not only affected lives but have also caused extensive damage to Haiti's telecommunications infrastructure. Addressing the aftermath goes beyond immediate emergency telecommunication assistance. The International Telecommunication Union (ITU) plays an important role in assisting Haiti in the reconstruction of its telecommunications infrastructure in alignment with the World Telecommunication Development Conference (WTDC) Resolution 60 (Hyderabad, 2010). Recognizing the crucial role of connectivity and the necessity for a robust, resilient, secure, and affordable telecommunications infrastructure to promote social welfare and economic development in Haiti, an assessment on resilience was conducted.

In this context, the report examines three pivotal areas of assessment. First, there was an evaluation of the damage to Haiti's networks and infrastructure after the 2021 earthquake, along with the restoration of telecommunication services. Second, the assessment focused on Haiti's country-level resilience, encompassing network/Internet Service Provider (ISP) resilience, critical infrastructure resilience, market resilience, as well as the resilience of operators across various sectors. Third, there was an evaluation of the preparedness of emergency telecommunications in Haiti. The report concludes with recommendations tailored to each assessment area, with the goal of enhancing Haiti's preparedness in emergency telecommunications. The methodology employed in this assessment adhered to the framework outlined in the Connect2Recover initiative, titled "Connect2Recover: A methodology for identifying connectivity gaps and strengthening resilience in the new normal."

I trust that this report will be a valuable resource, and I encourage industry stakeholders, with the support of the Haiti's Ministry of Public Works, Transport and Communications and CONATEL, to utilize it as a foundation for ongoing discussions and to implement the recommendations for the rebuilding and strengthening of Haiti's infrastructure and networks.

Cosmas Luckyson Zavazava
Director, ITU Telecommunication Development Bureau

Executive summary

Telecommunication and information and communication technologies (ICTs) networks form the backbone of our modern societies. These interconnected and interoperable networks do not only provide services for the ICT sector but also all other sectors of the economy such as education, health, job creation, transportation, trade and others. Any type of failure in the service provisioning may cause disruption to seamless services offered to the communities, consumers, government as well as the private sector resulting in a substantial loss of time and money. Disruption in delivery of telecommunication/ICT services nowadays is similar to a black out resulting in failure to deliver critical citizen services impacting lives as well as livelihood.

The instant reaction of any individual in times of disaster is to use any available means of electronic communication to connect with loved ones. In a broader perspective, telecommunications are the means of communication that can be mobilized before, during and after natural disasters to save lives and to guarantee a rapid return to normal. What if the telecommunication networks themselves are affected, in such a way that they cannot serve the users during times of hazard? Since telecommunication networks play a critical role for users in normal times and during distress, they must be protected to guarantee availability and permanence at all times. Like any other systems, telecommunication networks are exposed to various kinds of threats such as:

- malicious attacks such as cable theft, signal jammers, cable damages, and anti-satellite weapons;
- non-deliberate threats including system failures, power failures, and cable damages;
- natural hazards such as hurricanes, earthquakes, flooding, and tsunami.

During the occurrence of a disaster, telecommunication networks and infrastructure may suffer from physical destruction of network components, resulting in disruption in supporting infrastructure and network congestion.

Due to all kinds of threats, telecommunication systems need to be resilient to be able to withstand damages and continue to guarantee an acceptable level of service. In many countries, telecommunication networks and infrastructure have been severely damaged or completely destroyed by past disasters, and the negative impacts were significant for all stakeholders.

Three natural disasters (12 January 2010 earthquake, 4 October 2016 hurricane, and 14 August 2021 earthquake) have affected the networks and infrastructure in several areas in Haiti. The recovery costs are high and represent an obstacle to the development of the networks. On each of these occasions, the International Telecommunication Union (ITU) has always acted quickly by deploying staff and emergency telecommunication equipment to help the Haiti administration to manage the rescue and relief operations and return to normal. In collaboration with Conseil National des Telecommunications (CONATEL), the Haiti regulator, ITU has decided to carry out an assessment of the resilience of telecommunication networks and infrastructure deployed in Haiti. This assessment was carried out in accordance with Connect2Recover methodology. The Connect2Recover initiative was launched by ITU in September 2020 in response to the COVID-19 pandemic and to assist countries to reinforce their digital infrastructure and ecosystems and remain resilient in times of natural hazards.

In this context, an assessment of the existing restoration plan and the current level of resilience was conducted. To do so, relevant data was collected from the mobile network operators (MNO) and Internet service providers (ISPs) through questionnaires. Furthermore, during separate interviews, additional information was received from stakeholders including their challenges and needs. An assessment of the broadcasting sector was also performed by analysis of available data; this was completed with interviews with leading technical managers of several radio and TV stations. Besides that, the level of connectivity of the rural populations was measured during field trips. The assessment, based on the acquisition, collection, analysis and interpretation of data, indicates that:

- the overall capacity to recover or reconstruct by mobile operators and the leading ISP varies from 60 to 75 per cent;
- the overall resilience of the telecommunication market varies from 60 to 80 per cent;
- the level of connectivity is low in rural areas, most of the connections depend on a signal having a strength of –90 dBm;
- a very low level of broadband Internet penetration still prevails in rural areas where 2G is predominant;
- less than 10 per cent of radio and TV stations have the means to recover from damaged infrastructure caused by a disaster; and
- the overall resilience of radio and TV stations is very low.

The passive resilience of telecommunication networks and infrastructure depends on equipment and architecture, while active resilience is the reaction capacity or the adaptation capacity of each operator. The quality and type of equipment should be guaranteed by the equipment manufacturer. The redundancy strategy is mainly the responsibility of the service providers/ operators. The existing architecture needs to be improved, especially in terms of route diversity:

- the results of this assessment will help decision makers and stakeholders take action to consolidate the existing recovery capacity and resilience level;
- they should take appropriate measures to increase their recovery capacity, and particularly strengthen their resilience to future disasters.

The projects underway by both the regulator and telecommunication operators should give a significant boost to the development of the sector in Haiti.

Table of contents

List of figures, tables and boxes

Figures

Tables

Boxes

List of abbreviations and acronyms

Abbreviation/ Acronym	Definition
AHTIC	Association haïtienne pour le développement des Technologies de l'Information et de la Communication (Haiti association for the development of ICTs)
AMIH	Association des medias independants d'Haiti (Association of independent media of Haiti)
ANMH	Association nationale des médias d'Haiti (National association of Haiti medias)
AS	autonomous systems
BCM	business continuity management
BCP	business continuity plan
BTS	base transceiver station
CB	cell broadcast
CONATEL	Conseil national des telecommunications (national council of telecommunications)
COSTU	Comité sectoriel sur les telecommunications d'urgence (sectoral committe on emergency telecommunications)
DCM	disaster connectivity map
DDOS	distributed denial of service attack
DNS	domain name server
DPC	Direction de la protection civile (directorate of civil protection)
ENISA	European Network and Information Security Agency
ETC	Emergency Telecommunications Cluster
EWS	early warning system
GNI	gross national income
GSIS	Groupe de support en Informatique et statistique (IT and statistics support group)
GSMA	Global System for Mobile Communications Association
GVF	Global VSAT Forum
HLR	home location register
ICT	information and communication technologies
IFRC	International Federation of Red Cross and Red Crescent Societies
IP	Internet Protocol
IPv4	Internet Protocol version 4

(continued)

Abbreviation/ Acronym	Definition
IPV6	Internet protocol version 6
ISOC	Internet Society
ISP	Internet service provider
IT	information technology
ITDRC	Information Technology Disaster Resource Centre
ITU	International Telecommunication Union
IXP	Internet exchange point
MICT	Ministère de l'Intérieur et des Collectivités territoriales (Ministry of Interior and territorial collectivities)
MNO	mobile network operator
MSB	Swedish Civil Contingencies Agency
MTPTC	Ministère des Travaux publics, transports et communications (Ministry of public works, transportation and communications)
N/A	not applicable
NETP	national emergency telecommunications plan
NGO	non-governmental organization
OCHA	Office for the coordination of humanitarian affairs
PNH	Police Nationale d'Haiti (National Police of Haiti)
QoS	quality of service
RDDH	Réseau de Développement Durable d'Haïti (Sustainable Development Network of Haiti)
SAKS	Sosyete Animasyon Kominikasyon sosyal (Society for Animation and social Communication)
STL	studio transmitter link
TSF	Telecommunications Sans Frontières (Telecommunications without Borders)
VSAT	Very Small Aperture Terminal
WFP	World Food Programme
WVI	World Vision International

1 Background

1.1 Introduction

Haiti is a longstanding member of the International Telecommunication Union (ITU), and as such has benefited from different types of assistance such as capacity building training, technical assistances and infrastructure building. During past natural disasters, ITU has deployed emergency telecommunication equipment to help the government to manage relief operations. In the aftermath of recent earthquakes, ITU has facilitated timely delivery of emergency telecommunication equipment to the Haiti Government.

In consideration of the long-term benefits of the Haiti population, ITU through the Connect2Recover initiative focused on supporting resilient telecommunication networks and infrastructure in Haiti to ensure better preparedness in emergency telecommunications. In this context, ITU recruited an expert to assess the resilience of the telecommunication networks.

This study provides a thorough analysis of the fixed, mobile, broadcasting and Internet service provider (ISP) networks, and makes relevant recommendations towards the improvement of resilience to future natural disasters. This initiative was completed with the full cooperation of the Conseil national des telecommunications (national council of telecommunications), CONATEL, the Haiti telecommunications and information and communication technologies (ICT) sector regulator.

1.2 Rationale for the assessment

Given the importance of the telecommunication services in a society, be it in normal situations, or catastrophic events, a country should have telecommunication networks and infrastructure that can handle emergency needs. Telecommunications services play a vital role in the prevention, preparedness, response and recovery from all kinds of disaster, and a telecommunication network that can be mobilized at any time is very important.

Haiti is exposed to different types of natural disaster that heavily impacts the population and damages telecommunication networks and infrastructure that are essential during response and recovery phases. It is worth noting that the emergency service has a separate VHF radio network, with the capability and capacity to cover the entire country. The situation faced with the recent earthquake is a good example. The level of response and the speed of recovery directly depends on the telecommunication network's availability and a resilient network is needed to cope with emergencies or hazardous situations.

In this context, the following steps are necessary to ensure that telecommunication networks are resilient to damage, and will be available during and in the aftermath of any kind of disaster:

- assessment of impact of damage incurred to telecommunication networks and infrastructure;
- assessment of the existing restoration plan of the operators;
- assessment of the level of resilience of existing networks and infrastructure; and
- proposal of solutions to improve both the restoration plan and the current level of resilience of the telecommunication networks and infrastructure.

Taking into account its vulnerability to natural disasters, Haiti needs to rely on resilient telecommunications that can be mobilized by government agencies and the population in

times of emergency. This can be done by mobilizing the synergy of government (CONATEL) and the telecommunication/ICT operators.

1.3 Assessment approach

1.3.1 Assessment objectives

The objectives of the resilience assessment are to:

a) collect data on the damages to networks and infrastructure;
b) assess the existing restoration plan;
c) assess the resilience of networks and critical infrastructure; and
d) assess quality of service from a customer perspective.

1.3.2 Assessment methodology

The assessment will be based on three pillars:

- analysis of data collected from the regulator and operators;
- interviews with the regulator and the operators on the restoration plan and networks and infrastructure resilience, and the lead technical managers of broadcasting and Internet exchange points; and
- field trips mostly in the affected areas for the assessment of the level of connectivity.

All steps in this assessment are based on the methodology in the framework of the Connect2Recover initiative entitled: *Connect2Recover: A methodology for identifying connectivity gaps and strengthening resilience in the new normal*.

Through the analysis of the current situation, the effectiveness of the restoration plan along with the level of resilience of each network will be assessed. Those parameters will be measured against international best practice. Based on the results of the analysis performed, relevant recommendations have been made to stakeholders.

This study reports on the damages incurred to telecommunication networks and infrastructure by the most recent earthquakes. It presents the current situation of emergency telecommunications in Haiti, assesses the existing disaster recovery plans of operators, and the resilience of networks and infrastructure of telecommunication operators. It also covers connectivity in rural areas and makes a series of implementable recommendations.

2 Haiti and the telecommunication sector

2.1 Country presentation

Haiti is a Caribbean country with 11 946 331 habitants, according to the latest estimate. Its area is 27 750 km[21]. as shown in Figure 1 Its official languages are: French and Creole. Haiti is ranked 82nd out of 196 countries, and has a high population density, with 411 people per km[22].

Figure 1: Map of Haiti

Source: https://www.mapsofindia.com/world-map/haiti/

Note: The designations employed and presentation of material in this publication, including maps, do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area, or concerning the delimitations of its frontiers or boundaries.

The economic situation of the country is negatively impacted by different factors: political instability, increasing violence and fragility. One of the poorest countries in the world, Haiti had a GDP of 2 925 USD in 2020, according to World Bank data. On the human development index, it is ranked 170 out of 189 countries in 2020. About 60 per cent of the population live in abject poverty. Two thirds of the population live in rural areas. Haiti has the greatest inequity in the region. The richest who represent 20 per cent of the population hold 64 per cent of the total wealth, and the poorest 20 per cent of the population, have access to 1 per cent of the wealth or less[3].

1 https://www.cia.gov/the-world-factbook/countries/haiti/.
2 https://www.worldometers.info/world-population/haiti-population/.
3 World Bank news available at: https://www.worldbank.org/en/news/feature/2014/07/11/.

More than 96 per cent of the population are exposed to natural disasters. The economic damage of the last earthquake is estimated at 1.11 billion, which is 7.8 per cent of Haiti's 2019 GDP.[4] The telecommunication/ICT sector contributes significantly to the economy of the country in terms of job creation, licence fees and taxes. More than 3 000 jobs are contributed directly from the telecommunication and ICT sector.

2.2 Haiti and natural disasters

Haiti is often hit by cyclones, tropical storms, and hurricanes. Other disasters such as: droughts, torrential rains, floods, landslides, earthquakes occur occasionally in Haiti. On 12 January 2010, the country was hit by a major earthquake, leaving more 220 000 dead and 300 000 wounded[5]. That natural disaster destroyed the main infrastructure in the country. Subsequently, Hurricane Matthew, a Category 4 hurricane, hit Haiti on 4 October 2016. Wind, coastal flooding, and rain caused heavy flooding, and landslides mostly in the southern part. The negative impacts were the destruction of infrastructure, agricultural crops, and natural ecosystems. The death toll was assessed at 546.

On 6 October 2018, an earthquake with the magnitude of 5.9 occurred 20 km north of Port-de-Paix (Northwest). This earthquake affected several departments of Haiti and caused 12 deaths and wounded 151 persons. On 14 August 2021, another earthquake struck the South of Haiti. The Directorate of Civil Protection, which acts as the Executive Secretariat of the national risk and disaster management system, announced that it had officially ended the search and rescue mission in three departments in the south on Friday, September 3, 2021. This announcement coincided with the publication of the progress report of the National Emergency Operations Centre, which established the number of deaths (2 248), people injured (12 763) and missing (329) in three heavily affected departments[6].

Citing a satellite assessment by the World Bank, the report stated that the damage and economic loss suffered by the country are estimated at USD 1.5 billion, or about 10 per cent of the national gross domestic product (GDP). In addition, the earthquake directly affected approximately 690 000 people, which represents 40 per cent of the total population of Grand'Anse, Nippes and the Sud.

In the three affected departments, the report continued that there were 83 770 houses that were either slightly or heavily damaged, and 53 815 houses were destroyed. Initial assessments conducted after the earthquake showed that the percentage of houses destroyed in rural areas – where up to 80 per cent of the affected population lives–was on average five to seven times higher than in urban centres[7].

---

4 World Bank in Haiti available at: https://www.worldbank.org/en/country/haiti/overview#1.

5 United Nations, UN marks anniversary of devastating 2010 Haiti earthquake, available at: https://news.un.org/en/story/2022/01/1109632.

6 Analyse Rapide Genre: Tremblement de terre du 14 août en Haïti, available at: https://reliefweb.int/report/haiti/analyse-rapide-genre-tremblement-de-terre-du-14-ao-t-en.

7 Contribution of the post-disaster needs assessment (pdna) and the implementation of the recovery strategy through the DISASTER RECOVERY FRAMEWORK (DRF), available at: https://rb.gy/yuc0sq.

2.3 Geographic departments affected by the recent earthquake

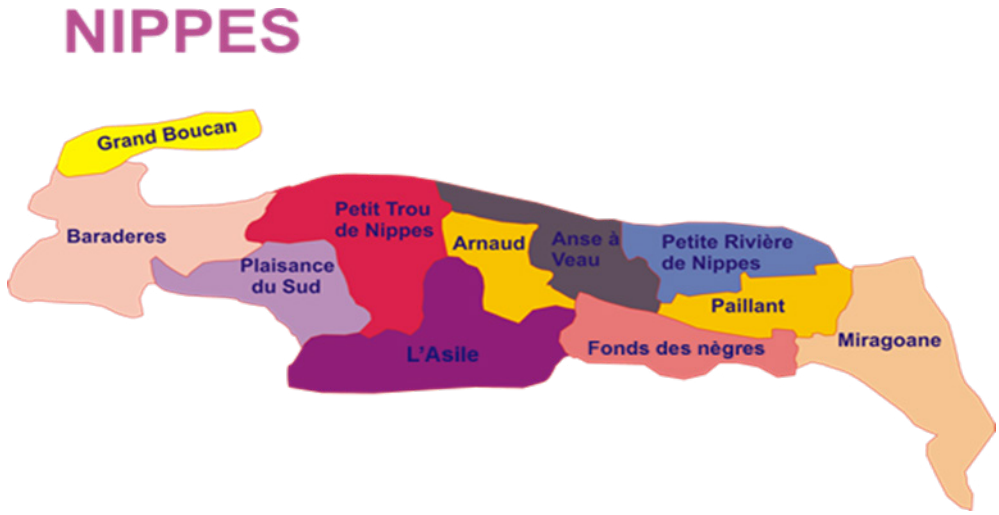
Three departments in the southern part of the country that were severely affected were: Nippes, Sud and Grand'Anse. The following tables and figures provide details on these areas hit by the earthquake.

Table 1: Departments affected

Department	Population	Area (km²)	Commune	Density (Pop/km²)
Nippes	342 525	1 268	11	246
Sud	774 976	2 654	18	266
Grand'Anse	468 301	1 912	14	245

Source: https://knoema.fr/atlas/Ha%c3%afti/GrandAnse

Figure 2: Map of Nippes



Source: https://rb.gy/wk7cmn

Note: The designations employed and presentation of material in this publication, including maps, do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area, or concerning the delimitations of its frontiers or boundaries.

Figure 3: Map of Sud

Source: https://www.cscca.gouv.ht/map/

Note: The designations employed and presentation of material in this publication, including maps, do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area, or concerning the delimitations of its frontiers or boundaries.

Figure 4: Map of Grand'Anse

Source: https://haiti.fandom.com/wiki/Grand'Anse,_Haiti

Note: The designations employed and presentation of material in this publication, including maps, do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area, or concerning the delimitations of its frontiers or boundaries.

2.4 The telecommunication sector in Haiti

The telecommunication sector in Haiti is organized in three levels: policy, regulation and operations in the market.

2.4.1 Policy of the sector

The Ministry of Public Works, Transportation and Communications (Ministere des Travaux Publics, Transports et Communications (MTPTC)) defines and leads government public policy in terms of telecommunications and ICT for the country. All policies, plans and visions of the government for this sector are handled by MTPTC.

2.4.2 Regulation of the sector

CONATEL is the regulatory body that was created in September 1969 to regulate the telecommunication sector. CONATEL is under the MTPTC. As a regulatory body, its main mission is to regulate the sector fairly. To do so, CONATEL uses the decree of 12 October 1977. All licences, concessions and authorizations are given under this decree. A new regulatory regime has been in preparation for two decades, but it has not been adopted to regulate this important sector. According to the existing law, monopoly of the telecommunication sector is granted to the State. CONATEL is a member of ITU and CITEL. The regulatory body is very active in ITU, mainly in the Telecommunication Development Sector (ITU-D), where its delegates participate as vice-rapporteurs in the ITU-D Study Groups.

CONATEL is managed by a Director-General appointed by the government. All the other positions of Directors within the regulator are held by civil servants of the public administration.

The telecommunication sector is governed by:

- the decree law of 12 October 1977 granting the State a monopoly on telecommunication services;
- the decree law of 10 June 1987 redefining the CONATEL structure and mission; and
- the decree law of 17 September 1987 giving CONATEL technical means and a fee structure for the use of the radio spectrum.

2.4.3 Operations in the market

Before the liberalization of the market, the consumers relied on the incumbent operator, Telecommunications d'Haiti (TELECO) to access telecommunication services, mainly telephony services. TELECO could not meet the growing demand of the population due to a lack of development of its network. Because of the growing needs of the population in terms of telecommunication services, it was decided to liberalize the market in order to allow new operators to operate in the market. This process started in 1998. Today, the market is served by two operators that provide both fixed and mobile-network services: Digicel and Natcom.

Digicel entered the market in 2006 with a GSM network. This operator opened access to mobile services throughout the country. In 2010, TELECO, the incumbent fixed-network operator was partially privatized, and became known as Natcom. It is 60 per cent owned by Vietel (Viet Nam), and 40 per cent State owned. The 40 per cent is managed by the Central Bank of Haiti on behalf of the State.

Digicel and Natcom have about 8 million customers. Their networks have evolved from 2G to 4G. They have been granted licences to migrate their networks to 4G. Numerous locations have already been served with 4G services, but many other zones remain unserved, especially in rural areas for 4G service access. The two operators provide fixed and mobile telephony, mobile Internet access, and Internet cable services.

Digicel serves 4.8 million mobile and fixed customers, and Natcom has 2.9 million mobile and fixed subscribers, with a total of 7.7 million subscribers. The telephony market is dominated by mobile services, with more than 95 per cent of the market[8].

The fixed telephony market is quite insignificant. Only institutions, companies and a few residential customers use fixed wireless telephony. Before the mobile operators entered the market, less than 10 per cent of the population had a fixed-line telephone service from TELECO, the incumbent operator, which provided fixed services. TELECO was absorbed by Natcom, which provides mainly mobile services, and the fixed wireline market no longer exists.

The consequence is a concentration of mobile telephones within a family, hence the exponential growth of mobile telephony. According to ITU data, there were 6 000 fixed lines in 2020 for the two operators[9]. Digicel has a 70 per cent share of the market leaving Natcom with 30 per cent. The overall calculated teledensity of Haiti is 64 lines per 100 inhabitants. Internet usage has shown some progress among the young who use their mobile phones more and more to access the Internet[10].

It is worth noting that AccessHaiti and HAINET are two providers offering Internet service to the general public. HAINET does not own any infrastructure and is using the AccessHaiti network. Alpha Communication Network (ACN), another ISP, has been acquired by Digicel.

Haiti Data Network (HDN), the fourth Internet provider, only provides data transmission service to a restricted group of companies, therefore, it does not connect the general public. In the Haiti market, when reference is made to a sole Internet provider, it refers to the AccessHaiti network and infrastructure, which is used by itself and HAINET to provide services.

The Internet penetration rate is still low compared to neighbouring countries. According to the data available, it is around 37.3 per cent[11] in January 2021. The constraints to Internet development include: high illiteracy rate, low purchasing power, scarce electrical power, and unavailability of Internet in rural areas. However, there is an increasing interest for this service in urban areas. It is expected that with infrastructure development, the use of this service can be increased in the future.

The broadcasting sector has more than 398 radio stations operating in the FM band and 8 in the AM band. It also has 111 terrestrial TV stations. Most of the AM radio stations have been abandoned due to high operating costs. Four satellite TV providers are currently serving the whole country. Their packages include local and international TV programmes. Thanks to the

---

8 Irish cellphone entrepreneur banks on a smarter Haiti, available at: https://www.reuters.com/article/us-haiti-digicel-obrien-idUSBRE90F0AQ20130116.

9 https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.asp.

10 Explore All Countries Haiti, available at: https://www.cia.gov/the-world-factbook/countries/haiti/#communications.

11 Haiti – Technology: Internet penetration rate in Haiti available at: https://www.haitilibre.com/en/news-33072-haiti-technology-internet-penetration-rate-in-haiti-373.html.

large radioelectric coverage offered by satellites, all rural areas can access TV services[12]. Table 2 provides statistics on the telecommunication sector in Haiti and the number of service providers are listed in the Table 3 for each category of service.

Main indicators of the sector

Table 2: Telecommunication sector statistics

	2018	2019	2020
Fixed-telephone subscriptions	5 922	5 952	6 000
Fixed-telephone subscriptions 100 inhabitants	0.05	0.05	0.052
Mobile-cellular telephone subscriptions; by post-paid/ prepaid	6 602 878	6 843 380	7 443 050
Mobile-cellular subscriptions per 100 inhabitants	59.36	60.76	
Percent individual using Internet	32.47	33.30	34.5
Fixed-broadband subscriptions	31 100	31 100	31 100
Fixed broadband subscriptions per 100 inhabitants	0.28	0.28	0.27
Active mobile-broadband subscriptions	3 335 050	3 060 889	3 231 000
Active mobile-broadband subscriptions per 100 inhabitants	29.98	27.18	28.09
International bandwidth; in Mbit/s	3 072		

Source: ITU database

Table 3: Telecommunication service providers

Services	Providers
Telephony	2
Internet	4
Radio (FM)	347
Terrestrial TV	131
Satellite TV	4

[12] De la radiodiffusion en Haïti à l'heure de la diversité available at: https://www.unesco.org/fr/articles/de-la-radiodiffusion-en-haiti-lheure-de-la-diversite.

2.5 Telecommunication market and infrastructure

Cellular telephony is the predominant service in the market with a 64 per cent penetration rate[13]. The Internet penetration rate is growing despite many challenges. Most of the connections are wireless, whilst a low percentage of users get connected through optical cable to benefit from high-speed connections.

The national backbone consists of a fibre-optic network and microwave links. International access for the telecommunication market is provided via:

- microwave links (established with the Dominican Republic);
- satellite links; and
- submarine cables (the Haiti – Bahamas cable, Columbus cable from the United States of America, and Claro cable from the Dominican Republic).

Currently, international access is diversified in the telecommunication market. The international access consists of two submarine cables (Batelco and Columbus); one terrestrial underground cable (established between Haiti and the Dominican Republic); several microwave links (established between Haiti and the Dominican Republic); and several satellite links, used mainly by satellite television operators. The market is served by about ten international gateways, while international organizations and private companies use their own satellite gateways for Internet connections. As such, the total number of international gateways cannot be clearly established.

The results of the questionnaire 1 are shown in Table 4 for Digicel, Table 5 for Natcom and Table 6 for AccessHaiti. The results include data on the customer base, the technologies used, the coverage, the capacity, and the international bandwidth for each operator and ISP.

Questionnaire 1: Market and infrastructure

Table 4: Digicel

Market and Infrastructure	
Number of customers	4 800 000
Number of base stations (2G, 3G, 4G)	1 506 (Total)
	2G: 1503
	3G: 1110
	4G: 869
Average telephone traffic per user	41mErlang
Average data traffic per user	10.5 GB
Territory coverage	95 per cent geographic coverage (GSM)
Network capacity	8.2 M capacity on Home Location Register HLR

[13] Mobile subscription penetration Haiti 2021, available at: https://www.statista.com/statistics/502111/mobile-cellular-subscriptions-per-100-inhabitants-in-haiti/.

Table 4: Digicel (continued)

Market and Infrastructure	
Number of km deployed (optical fibre)	Backbone: 1 642 km (58% Aerial / 42% Underground)
	Connection:
International bandwidth	70 Gbit/s
Number of international access	1
	Submarine cable (based at Kaliko from Columbus from the United States)

Source: Digicel data

Table 5: Natcom

Market and Infrastructure	
Number of customers	2 909 673
Number of base stations (2G, 3G, 4G)	1 120 (Total)
	2G: 978
	3G: 773
	4G: 801
Average telephone traffic per user	–
Average data traffic per user	–
Territory coverage	2G: 95%
	3G: 75%
	4G: 82%
Network capacity	TU 2G: 70 % (Traffic Unit)
	TU 3G: 80% (Traffic Unit)
	TU 4G: 81% (Traffic Unit)
Number of km deployed (optical fibre)	Transmission: 5 056.65
	Connection: 2 000
International bandwidth	50 Gbit/s

Table 5: Natcom (continued)

Market and Infrastructure	
Number of international access	3
	1 Submarine cable (based at Kaliko from Columbus, United States)
	1 Submarine cable (based at Port-au-Prince from Batelco, Bahamas)
	1 underground cable (established with the Dominican Republic)

Source: Natcom data

Table 6: AccessHaiti

Market and Infrastructure	
Number of customers	20 000
Number of base stations (Wimax, 4G)	4G: 150
Average data traffic per user	50 – 60 GB
Territory coverage	Main cities
	Some rural areas
Network capacity	Hundreds of GB
Number of km deployed (optical fibre)	Transmission: 2 400
	Connection:
International bandwidth	25 Gbit/s
Number of international access	3
	1 Submarine cable (based at Kaliko, from Columbus, United States)
	1 Submarine cable (based at Port-au-Prince, from Batelco, Bahamas)
	1 Microwave link (established with the Dominican Republic)

Source: AccessHaiti data

2.6 Use and development of telecommunication/ICT in Haiti

The use of telecommunication/ICT is hindered by several factors: unavailability of the service nationwide, low access rate to electricity, low purchasing power of the population, high illiteracy rate, resistance to change, and lack of awareness. With a teledensity of 67 per cent, Internet penetration rate of 37.3 per cent, and about 2 million smartphones, Haiti has the lowest ICT indicators in the region[14]. The obvious proof is that the country-code top-level domain (ccTLD = .ht domain) has only been adopted so far by 583 entities. 2G coverage is still predominant in

[14] Zones Files country code domain list is available at: https://zonefiles.io/cctld-domains/.

rural areas, while 4G networks are concentrated in the main cities, particularly, the capital city, Port-au-Prince. The leading ISP covers only the main cities. The use of telecommunication/ICT in Haiti is mainly focused on pure communications between contacts, while commerce, economy, education, medicine, agriculture, and job creation have yet to benefit from these technologies.

Broadband connections are limited to the main cities, and very few customers have fibre-optic connections. Radio and TV stations face several issues, including recurrent radioelectric interference, limited coverage, and financing. The process of transition from analogue to digital television, which was launched nine years ago, is still at an experimental stage. This delay in the transition process prevents operators and the State from benefiting from the digital dividend expected from the frequencies released by analogue television. Amateur radio and Citizen's Band (CB) are used by a very low percentage of the population, despite their usefulness during emergency situations.

Electronic commerce and electronic-government services are not very developed. Only a few government institutions manage to offer online services to the citizens. Electronic commerce is used by a low percentage of the population. The local language, Creole, is used in some websites, and social media. However, less than 13 per cent of applications are in the local language.

The absence of a national plan for the development of the sector is seen as a major cause. The reform of the legal framework initiated more than twenty years ago is not yet complete, which also hinders the development of the sector. Stakeholders need to move forward on the adoption of a public policy for the sector. Policy and regulation have the potential to create a supportive environment and can attract investments and facilitating the development of the sector. Policy and regulation are also the foundation of the digital strategy that will lead further to digital transformation. A broadband plan is also needed to meet the growing demand of users and applications.

One Internet Exchange Point (IXP) serves the entire population of Haiti, which is estimated at 11.5 million inhabitants. Created in 2009 by an association of private operators, this technical infrastructure is managed by the Association haitienne pour le developpement des Techonologies de l'Information et de la Communication (the Haiti association for the development of ICTs (AHTIC)).

The .ht domain was launched in 1997 and is managed by Reseau de developpement durable d'Haiti (sustainable development network of Haiti (RDDH)).

Several international institutions are involved in the development of telecommunication/ ICT sector in Haiti. ITU provides substantial assistance at different levels including: legal framework reform, training programmes, transition to digital television, frequency management, emergency telecommunications, telecommunication networks and infrastructure assessment, and rural connectivity. The World Bank and the International Development Bank are also helping Haiti to benefit from digital technologies and in different areas. The World Bank is currently assisting the country, through the regulator, CONATEL, in different projects such as emergency telecommunications, connectivity, broadband and control of quality of service.

2.7 Telecommunication sector projects

The sector has not reached its full development in Haiti due to various challenges such as the absence of a clear policy and vision, unfavourable environment (such as lack of security for the operations, community disturbance, vandalism on telecommunication infrastructure), lack of basic infrastructure and incentives. Different telecommunication projects conceived and managed by the Haiti administration, and which are supported by international institutions and partners can accelerate the development of the sector and boost digital usage of ICT in a broader perspective in Haiti. CONATEL is currently working on several projects:

- creation of favourable environment;
- capacity building;
- development of the digital infrastructure;
- emergency telecommunications;
- monitoring and control equipment for the spectrum and quality of service; and
- national transport backbone.

The operators and Internet services providers (ISPs) are planning the expansion of their networks to meet the new demand. They are establishing a new ring in the main cities to increase redundancy in their systems, and are implementing new solutions, both in the areas of telecommunications and electric power supply.

3 Telecommunication networks damage assessment

3.1 Failures of telecommunication systems during disasters

Failure of network is caused by the complete or partial failure of a component or components arising from malfunction, natural or human-caused disasters.[15] Once a part or a key component of the network and infrastructure is affected in such a way it can no longer operate within the system, there is a technical dysfunction. This failed component may affect a part of the system, or the entire system, with the negative consequences of unavailability of service.

During disasters, telecommunication networks and infrastructure may fail in different ways, and the impacts vary from one cause to another. The failure of telecommunication systems can have three primary causes:

1) physical destruction of network components;
2) disruption in the supporting network infrastructure; and/or
3) network congestion.[16]

Physical destruction of network components is the most common cause. In this case, telecommunication networks and the infrastructure components may suffer damage, and they can be partially or completely destroyed. Different components can also be affected during a disaster. When the core network is damaged or destroyed, all the users will be affected. If only a component of the infrastructure deployed is hit, for example, the component that serves the local area, the negative impact will remain local. The backbone cable damaged at a particular point will lead to a complete breakdown for the entire network if there is no redundancy. In comparison, a base station damaged or destroyed can only affect the area served.

Wired telecommunication infrastructure as well as wireless infrastructure are subject to damage and destruction during disasters. Floods, earthquakes and tsunami may have greater impact on terrestrial and submarine infrastructure (for example, cables), while cyclones, winds, hurricanes can damage or destroy components of wireless infrastructure (such as antennas and towers).

The less common cause of failure is disruption in the supporting network infrastructure. This kind of failure concerns power systems, cooling systems, transportation, buildings, and transmission sites. Power is needed to operate all parts of a telecommunication system. Once the power systems are affected in such a way that they cannot provide electricity to the telecommunication networks and infrastructure, there will be a complete halt to the service.

This kind of failure may occur if the commercial power grid is affected. When the cable linking the power generator to the system is cut off, there will be a huge negative impact. If the cooling systems stop working due to damage, the servers of the systems cannot continue to operate. When access roads are cut off, the supply of fuel for the generation of electric power becomes impossible, hence, this leads to disruption of service. When the building that hosts several critical components of the system collapses, there will be no access to the resources, and this will result in network dysfunction.

---

[15] Network failure available at: https://itlaw.fandom.com/wiki/Network_failure#:~:text=Definition,natural%20or%20human%2Dcaused%20disasters.

[16] Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications.

The third cause of failure is network congestion or overload of the network. This is caused by the natural reaction of every customer or user after a natural disaster to try to connect with their families, their friends, and their other contacts. Moreover, the need to coordinate response activities is certainly another source of intensive use of electronic communications. When a high percentage of customers want to connect simultaneously, the network will be congested. telecommunication networks are not designed to serve all the users at the same time, they are optimized to connect a percentage of them at one time. The dimensioning of the network capacity both in terms of transmission and switching is decided during the design of the network and cannot be changed because of an increase in the volume of calls. When huge volumes of traffic resulting from the crisis cannot be managed by the network, it will cause congestion. If the network is dimensioned for 10 per cent of the customer base, it will be impossible to serve one additional user. Under these constraints, calls can be blocked, or the messages can be lost. Due to the incapacity of the network to serve all simultaneous requests for connections, users will perceive the network as a failed network in times of urgent need. It is crucial to understand that a huge volume of traffic can lead to a breakdown of the network. For example, after the September 11 attacks, mobile telephone networks in the United States were brought down by congestion.[17] It is important to note that congestion can occur in two different ways:

- high peak of traffic after a disaster within an undamaged part of the network; and/or
- reduction of network capacity to handle traffic due to damage or destruction of its components.

3.2 Damages incurred to networks and infrastructure

Earthquakes have the potential to damage or destroy any type of physical infrastructure (such as, buildings and equipment). When there is physical damage to the infrastructure and network components, the operations of the network are highly affected, and could lead to unavailability of service. Generally, the consequences are network congestion and a loss or unavailability of telecommunication services.

The level of resistance mainly depends on the solidity of the infrastructure and/or the strength of the earthquakes. The negative impact can also be observed in fibre-optic or cable infrastructure after floods, earthquakes, cyclones, fires and other disasters. Microwave links are also likely to suffer disruption when they are hit by high levels of rain fade or attenuation. Very small aperture terminal (VSAT) units can suffer physical damage in different ways from wind or debris. There may be alignment issues due to wind and increased attenuation or rain fade.[18]

The type and quantity of damages suffered depend mainly on the following factors: type of natural disasters, amplitude of the disaster, resilience of telecommunication networks and infrastructure, and resilience of the supporting infrastructure (such as power systems, cooling systems, sites and buildings).

3.2.1 Damage assessment conducted by the regulator

In the aftermath of the earthquake, the regulator held several meetings with the mobile operators and the ISP to assess the extent of damage sustained in their networks and infrastructure. The

[17] Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications.

[18] Building a Resilient Industry: How Mobile Network Operators Prepare for and Respond to Natural Disasters available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/03/TWP5861_BuildingAResilientIndustry_v003.pdf.

meetings also focused on the areas unserved as a result of the earthquake, and the kind of connectivity strategies the providers put in place to offer minimal connectivity to the survivors living in the affected areas. Based on the data provided by the operators, the regulator could identify the nature and the extent of damage and destruction to infrastructure. During those exchanges, they also discussed the means and measures to completely restore the networks.

The operators presented several areas that were affected by the unavailability of service following the damage and destruction of infrastructure. During those meetings, they committed to making every possible effort to restore the network in order to reconnect the users as soon as possible. While the restoration process was ongoing, the operators offered free minutes and data for a certain period of time. These free allocations were targeted at the most vulnerable population.

The regulator also provided its assistance throughout the recovery process. Table 7 provides details on the extent of damage suffered, and the types of assistance provided to the government, affected population and employees.

Table 7: Damages reported to the regulator, and assistance provided

Digicel		Natcom	
Damage incurred	Assistance to government and affected population	Damage incurred	Assistance to government and affected population
Sites were damaged There was displacement of materials (batteries and other equipment) Slight damage to pylons, and fences were damaged There was network congestion on the day of the earthquake Other difficulties encountered: – Access roads were cut off or blocked	Donation of fuel to the regional office of Civil protection, hospitals, and the Ministry of Public Works Logistical support was provided to the Ministry of Health Free credit provided to the Ministries of Public works and Health Installation of free dedicated Internet links at 3 institutions in the Sud 1-month free broadband Internet was provided to all partners in the south; 10 GB free call and chat via BIP *Every day from 16 August onwards:* 5 minutes local call every day 1-minute international call 200 SMS to 920 000 customers in the south 10 GB free call and chat via BIP *From 19 August:* 200 MB to 920k customers	50% of the Base Transceiver Stations (BTS) in the southern region were damaged Some fences were destroyed Some radio or fibre-optic backbone equipment were destroyed Links were cut on the day of the earthquake Service was fully restored 24 hours after the earthquake Other difficulties encountered: – Access roads were cut off or blocked – Difficulty in getting fuel to BTS	Donation of fuel to the hospitals of the south ern region Distribution of 300 parasols For five days the following was provided to 149 000 customers: 10 minutes of Natcom- Natcom calls per day 200 MB per day USD 100 and 1 bag of rice to Natcom employees Advance on salary to Natcom employees

Source: CONATEL

3.2.2 Damage data collected from the operators

In order to collect precise data on the damage and destruction of networks and infrastructure, specific questionnaires were sent to the two mobile operators, Digicel and Natcom; and the leading ISP, AccessHaiti. For Digicel and Natcom, which have infrastructure deployed in the southern part of the country, the damage concerned base stations, transmission sites, towers, and other logistical facilities. For the operator Natcom, its backbone was affected, which impacted the entire area. AccessHaiti, the only ISP, which has a coverage in those affected areas, suffered damages in two sites.

As for the broadcasters, their overall situation was highlighted by the Society for Animation and Social Communication (Sosyete animasyon kominikasyon sosyal (SAKS))[19], an agency which manages the community radio stations, and the main newspaper[20, 21] of Haiti, journal Le Nouvelliste. Their situation was reported to include studio collapse, infrastructure damage, destruction of transmission site, and disruption of the energy supply as shown in Table 8 for Digicel, Table 9 for Natcom, and Table 10 for AccessHaiti. The results are based on Questionnaire 2.

Questionnaire 2: Damages to network and infrastructure

Table 8: Questionnaire 2: Digicel

Damages to network and infrastructure, issues, cost	
Nature of the damage incurred in the Sud	Sites were fully destroyed
	Sites suffered structural damage (boundary walls, gates and guardhouses)
	Access roads were damaged
	Retorquing was required for towers
Base transceiver stations (BTS) damaged in the Sud	2 sites were destroyed
	83 sites suffered from various damage listed above
Physical damages to transmission sites	Boundary walls collapsed, gates and guard-houses in many locations were damaged
Radio backbone or fibre-optic equipment destroyed in the Sud	Environmental damage to backbone sites (walls collapsed leaving sites vulnerable to theft and sabotage)
Links cut off on the day of the earthquake in the Sud	10 major hub sites affecting over 100 sites
Network congestion on the day of the earthquake	14% in the south, 2% overall
Estimated cost of damage to equipment	~ 1 million (USD)

[19] https://www.alterpresse.org/spip.php?article27366.
[20] https://lenouvelliste.com/article/231437/une-viree-a-beaumont-aupres-des-directeurs-de-medias.
[21] https://lenouvelliste.com/public/index.php/article/231420/reduit-au-silence-par-le-seisme-radio-telediffusion-cayenne-lance-un-appel-a-laide.

Table 8: Questionnaire 2: Digicel (continued)

Damages to network and infrastructure, issues, cost	
Strategy implemented for the restoration of the network following the earthquake	Nearest RAN/Fibre teams travelled to the affected areas within the first hours
	Communication was activated for emergency purposes by teams who travelled by car/plane/ boats

Source: Digicel

Questionnaire 2: Damages to network and infrastructure

Table 9: Questionnaire 2: Natcom

Damages to network and infrastructure, issues, cost	
Nature of the damage incurred in the Sud	Backbone and BTS were damaged
Base transceiver stations (BTS) damaged in the Sud	101
Physical damages to transmission sites	Boundary walls, gates and guardhouses collapsed in 40 sites in the Sud
	Boundary walls, gates and guardhouses collapsed in 10 sites in the Nippes
Radio backbone or fibre-optic equipment destroyed in the Sud	There were 5 misdirection of microwave links axis resulting in loss of connection
	9 microwave access links were misdirected result-ing in loss of connection
Links cut off on the day of the earthquake in the Sud	4 optical backbone links were affected
	30 optical access links were affected
Network congestion on the day of the earthquake	There was normal operation until the night of the earthquake on 14 August
	The impact on the services from 00 AM was due to an aftershock causing a breakdown of the underground backbone connection in Les Cayes
	Restoration of the services was completed on the night of 15 August
Estimated cost of damage to equipment	10 507 686.84 (USD)
Strategy implemented for the restoration of the network following the earthquake	Deployment on the ground of 5 support teams for the restoration
	Repair of some damaged equipment a few days later
	Complete recovery
	Addition of one more microwave link for protec-tion

Source: Natcom

Questionnaire 2: Damages to network and infrastructure

Table 10: Questionnaire 2: ISP AccessHaiti

Damages to network and infrastructure, issues, cost	
Nature of the damage incurred in the Sud	2 sites were damaged
	Towers were affected
Base transceiver stations (BTS) damaged in the Sud	N/A
Physical damages to transmission sites	2 towers were affected
Radio backbone or fibre-optic equipment destroyed in the Sud	N/A
Links cut off on the day of the earthquake in the Sud	N/A
Network congestion on the day of the earthquake	N/A
Estimated cost of damage to equipment	–
Strategy implemented for the restoration of the network following the earthquake	Reinforcement of 2 sites which were damaged

Source: AccessHaiti

Rooftop equipment, such as a BTS, is at a greater risk when earthquakes strike. They can also contribute to the collapse of the buildings which host them. In the case of Natcom, a majority of its transceivers were installed on roof-tops. The damages incurred by operators and the ISP include cut cables, damaged backbone cables, damaged BTS, destruction of transmission sites, displacement of telecommunication equipment and generators, disruption of power systems, damage to, or collapse of, structures (for example, fences, boundary walls and guardhouses).

The broadcasting sector was also very affected by that natural disaster. Local radio and TV stations operating in those 3 geographical departments have been seriously damaged or were completely destroyed. Only a small percentage of radio and TV stations could operate in the aftermath of the earthquake.

The technical teams repaired progressively the most critical parts of the network in a record time, and the rest in less than one week. The complete recovery of the networks was assessed both in terms of services availability and repair of damages. The damage in the broadcasting sector included a collapsed studio building, destruction of transmission sites, and disruption of power systems.

3.2.3 Damage to the power systems

The private power systems of mobile network operators (MNOs) and ISPs suffered disruptions and outages during the earthquake. The power systems of the transmission sites affected by the earthquake were also damaged. The most common damage of the power systems was disconnection of cables, cables being cut, fuel leaks and a fuel tank that fell. In several affected transceivers, the power generators were disrupted immediately or soon after the earthquake.

However, undamaged transceivers could continue to operate thanks to the availability of four-hour batteries.

3.3 Loss and cost to re-build

During the last earthquake, parts of the infrastructure were either partially damaged or were completely destroyed. The damage included cables being cut off, numerous disconnections, displacement of telecommunication equipment, generators, antenna disorientation, and fallen towers due to collapse of houses. The following table provides data on the percentage of damage and destruction to the operator/ISP infrastructure, and financial loss and cost to re-build.

Table 11: Impacts, loss and cost to re-build

Operator/ISP	Percentage of infrastructure affected	Percentage of infrastructure destroyed	Loss (USD)	Cost to re-build (USD)
Digicel	12.15	0.13	1 million	–
Natcom	13	–	10 507 686.84	–
AccessHaiti	1.33	–	–	–

Source: Digicel, Natcom and AccessHaiti data

The calculation of the percentage of infrastructure affected and destroyed is based on the number of BTSs deployed throughout the country, and the total of BTSs that were damaged and destroyed as reported by the operators.

3.4 Difficulties encountered in the aftermath of the earthquake

Following the occurrence of the earthquake, service providers and users experienced issues with service provision. The first reaction of the telecommunication operators was to assess damage and destruction, and restore service. MNOs, ISPs and broadcasters found it hard to restore service in affected areas. The main obstacles were:

- access roads and bridges were cut off or blocked;
- difficulty in getting fuel to the BTS (due to damage to access roads);
- transportation of equipment to the sites was affected; and
- mobilization of air transportation.

4 Restoration of telecommunication services

4.1 Network disaster recovery plan

Disaster recovery is the practice of anticipating, planning for, surviving, and recovering from a disaster.[22]Telecommunication networks (telephony, broadcasting, data transmission) must operate a permanent service to stay competitive. Whenever they suffer from damage or partial destruction that affect quality or level of service, they need to implement disaster recovery plans quickly. A disaster recovery plan enables businesses to respond quickly to a disaster and take immediate action to reduce damage, and resume operations as quickly as possible.[23] Disaster recovery plans describe the process, policies and procedures for responding to a disaster.

A network disaster recovery plan includes a set of procedures required to effectively respond to a disaster that affects a network and causes its disruption. Network disaster recovery planning generally entails:

- listing the steps which should be undertaken in order to restore network connectivity;
- identifying people responsible for conducting network disaster recovery;
- assessing possible consequences of a network failure; and
- determining the best strategies to mitigate them.[24]

By putting in place adequate policies, procedures and necessary tools and equipment, there is a guarantee that operations can resume as quickly as possible. The planning of a network disaster recovery should provide guidance to restore services and normal operations following a disaster. A network disaster recovery plan must also be designed to identify specific issues or threats related to a company's operations.

The restoration of telecommunication services is the first priority of any service provider and consists of connecting users quickly after the damage, destruction, or disruption caused by natural disasters or vandalism. In this context, the service providers must have strategies and resources. The restoration of services has two main technical components: availability of substitute or redundant network elements and the repair of damaged systems.

Telecommunication operators should consider developing the disaster recovery strategy in two steps, as described below:

Step 1: Disaster recovery planning

- identification and analysis of disaster risks/threats;
- classification of risks based on relative weights;
- building the risk assessment;
- determining the effects of disasters;
- evaluation of disaster recovery mechanisms; and
- establishing the disaster recovery committee.

---

[22] Disaster Recovery: 5 Key Features and Building Your DR Plan available at https://cloudian.com/guides/disaster-recovery/disaster-recovery-5-key-features-and-building-your-dr-plan/.

[23] Disaster Recovery: 5 Key Features and Building Your DR Plan available at: https://cloudian.com/guides/disaster-recovery/disaster-recovery-5-key-features-and-building-your-dr-plan/.

[24] How to create an effective network disaster recovery plan available at: https://www.nakivo.com/blog/create-effective-network-disaster-recovery-plan/.

Step 2: Disaster recovery phases

- activation phase;
- notification procedures;
- damage assessment;
- activation planning;
- execution phase;
- sequence of recovery activities;
- recovery procedures; and
- reconstitution phase.[25]

With adequate managerial and technical teams, appropriate material resources, and an adapted strategy, a telecommunication operator should be able to recover quickly.

4.2 Existing recovery strategy

To restore telecommunication services affected by natural disaster, the operators and ISPs in Haiti have technical teams and equipment in place across the country that contribute to the adaptation capacity and active resilience of each operator.

Those teams intervene for:

- regular maintenance: maintenance of telecommunication equipment and power systems; and
- restoration of service: repair and reconstruction following disruption.

The rapid intervention of teams is the first response to any incident, technical failure, or natural disaster. This strategy is implemented because operators want to avoid:

- deterioration of quality of service (due to technical failure or absence of maintenance);
- long travel time (the duration can be too long for technical staff based at the headquarters).

In case the technical failure is beyond the capacity of the teams in place, other teams are deployed quickly to help resolve the issues.

In the aftermath of the earthquake, operators were urged to restore telecommunication services in all affected areas as quickly as possible. Their interventions included the repair and replacement of equipment, reinforcement and readjustment of equipment, and displacement of materials. In order to restore the network after the 14 August 2021 earthquake, local teams were mobilized along with technical staff deployed from Port-au-Prince.

Thanks to the rapid interventions of teams in place in each department and the mobilization of other technical staff, and other means deployed, Digicel managed to restore in less than one week; Natcom restored its network in one day with five teams deployed; and AccessHaiti repaired the parts affected in one day. Table 12 summarizes the existing recovery capacity of each operator. Further, recommendations are formulated to improve the recovery capacity of MNOs and ISPs within three months and nine months respectively as shown in Box 1.

[25] Disaster Recovery: Best Practices available at: https://www.cisco.com/en/US/technologies/collateral/tk869/tk769/white_paper_c11-453495.pdf.

Table 12: Existing recovery capacity of MNOs and ISP

Operator/ ISP	Pre-positioned teams	Availability of repair/spare parts	Cell sites on wheels (COW)	Generators on wheels	Strategic fuel stock	Renewable energy
Digicel	X	X	X	X	X	X
Natcom	X	X			X	X
AccessHaiti	X	X		X	X	X

Source: Digicel, Natcom and AcessHaiti

Box 1: Recommendations: Recovery strategy

Key recommendations
Improvement of the recovery capacity within three months by: • acquiring or adding more cell sites on wheels (COWs); • acquiring or adding more generators on wheels. Improvement of the recovery capacity within nine months by: • complying with the standard acceptable delay of restoration; • pre-positioning teams all areas at risk; • acquiring cell on light truck (COLTs) transceivers to replace non-functioning base stations.

4.3 Requirements for network recovery

The ITU-T focus group on disaster relief systems, network resilience and recovery has defined requirements for network recovery and resilience.[26] These requirements will be used in this section to assess the existing recovery plans. The technical requirements and repair of redundant networks take into account satellite and core network components, fixed access and terminal equipment, mobile access and terminal equipment, Internet access, and electrical power supply. The availability and activation capability of critical elements or each component are verified by each operator. Although some equipment may be external to the operator network, their availability will also be checked. Table 13 sets out the technical requirements operators should meet for an efficient post-disaster recovery.

[26] Requirements for Network Resilience and Recovery, ITU-T focus group on disaster relief systems, network resilience and recovery, May 2014, available at: https://www.itu.int/en/ITU-T/focusgroups/drnrr/Pages/default.aspx.

Table 13: Network recovery

Parts of the Network	Item
Satellite	Portable earth station to reach the satellite
	Mobile base station with satellite entrances
Core Network	Spares for switching equipment and transmission facilities
	Materials for makeshift (emergency restoration construction, installation of temporary telecommunication lines, electrical power supply)
	Emergency restoration equipment (outdoor line trunk accommodation units, temporary repeater)
	Movable and deployable ICT resource units
Fixed access and terminal equipment	Special toll-free public phones
	Satellite mobile phones
	Repurpose resources from other stations (laying in cable from other areas and out-rigging of network facilities)
	Underground multipurpose duct of cables
Mobile access and terminal equipment	Large-zone (long reach) mobile base stations
	Mobile and compact base stations (including femtocells)
	Satellite mobile phones
Internet Access	Free access to wireless LAN and Internet including in evacuation centres
	Autonomous network construction for continuous communication (delay tolerant networking, local wireless mesh network with portable advanced wireless base station)
Electrical Power Supply	Power-supply car

Source: ITU

4.4 Substitute or redundant network elements and repair assessment

In order to assess the recovery plan of each operator, the following questionnaire was submitted to each operator and ISP for data collection. This questionnaire includes the standard components of networks and infrastructure that should be available for restoration in case of any disruption of service due to disaster or any failure. Apart from the networks and infrastructure elements, this questionnaire also includes separate and non-dependent systems of telecommunications, such as: portable earth station to reach the satellite and mobile base station with satellite entrances as shown in Table 13 for Digicel with its recommendation in Box 2, Table 15 for Natcom with recommendation in Box 3 and Table 16 for AccessHaiti with its recommendation in Box 4.

Recovery plan: Digicel

Recovery and reconstruction after disaster: Substitute networks and repair

Table 14: Questionnaire 3: Digicel

Parts of the network	Item	Yes	No	Comments
Satellite	Portable earth station to reach the satellite		X	
	Mobile base station with satellite entrances		X	
Core network	Spares for switching equipment and transmission facilities	X		
	Materials for makeshift (emergency restoration construction, installation of temporary tele-communication lines, electric power supply)	X		
	Emergency restoration equipment (outdoor line trunk accommodation units, temporary repeater)	X		
	Movable and deployable ICT resource units	X		
Fixed access and terminal equipment	Special toll-free public phones		X	
	Satellite mobile phones	X		
	Repurpose resources from other stations (laying in cable from other areas and out-rig-ging of network facilities)	X		Standardized networks - network compo-nents can be reused anywhere in the network
	Underground multipurpose duct of cables	X		
Mobile access and terminal equipment	Large-zone (long reach) mobile base stations		X	
	Mobile and compact base stations (including femtocells).	X		
	Satellite mobile phones	X		
Internet access	Free access to wireless LAN and Internet including in evacuation centres	X		Free minutes and data access to users in affected areas during several days
	Autonomous network construction for continu-ous communication (delay tolerant networking, local wireless mesh network with portable advanced wireless base station)	X		Modular system/partial network failure/stan-dardized components
Electric power supply	Power-supply car	X		

Source: Digicel

Table 14 shows that Digicel has in place 12 out of 16 items of the questionnaire for proper recovery, hence, the Digicel recovery capacity is at 75 per cent.

Box 2: Recommendations: Recovery - MNO1

Key recommendations
• Improvement of the recovery capacity within three months by adding more mobile satellite phones for recovery operations management. • Improvement of the recovery capacity within nine months by deploying special toll-free public phones for the population.

Recovery plan: Natcom

Recovery and reconstruction after disaster: Substitute networks and repair

Table 15: Questionnaire 3: Natcom

Parts of the network	Item	Yes	No	Comments
Satellite	Portable earth station to reach the satellite		X	
	Mobile base station with satellite entrances		X	
Core network	Spares for switching equipment and transmission facilities	X		
	Materials for makeshift (emergency restoration construction, installation of temporary telecommunication lines, electric power supply)	X		
	Emergency restoration equipment (outdoor line trunk accommodation units, temporary repeater)	X		
	Movable and deployable ICT resource units	X		
Fixed access and terminal equipment	Special toll-free public phones	X		
	Satellite mobile phones	X		
	Repurpose resources from other stations (laying in cable from other areas and out-rigging of network facilities)		X	
	Underground multipurpose duct of cables	X		Underground cable for transmission network
Mobile access and terminal equipment	Large-zone (long reach) mobile base stations	X		
	Mobile and compact base stations (including femtocells).	X		
	Satellite mobile phones		X	

Table 15: Questionnaire 3: Natcom (continued)

Parts of the network	Item	Yes	No	Comments
Internet access	Free access to wireless LAN and Internet including in evacuation centres	X		
	Autonomous network construction for continuous communication (delay tolerant networking, local wireless mesh network with portable advanced wireless base station)	X		
Electric power supply	Power-supply car	X		

Source: Natcom

It is noted that the mobile operator Natcom has implemented 12 out of 16 items in the questionnaire to meet recovery needs and has thus achieved 75 per cent.

Box 3: Recommendations: Recovery - MNO2

Key recommendations
• Improvement of the recovery capacity within three months by adding mobile satellite phones for recovery operations management. • Improvement of the recovery capacity within nine months by repurposing resources from other stations.

Recovery plan: AccessHaiti

Recovery and reconstruction after disaster: Substitute networks and repair

Table 16: Questionnaire 3: ISP

Parts of the network	Item	Yes	No	Comments
Satellite	Portable earth station to reach the satellite		X	
	Mobile base station with satellite entrances		X	

Table 16: Questionnaire 3: ISP (continued)

Parts of the network	Item	Yes	No	Comments
Core network	Spares for switching equipment and transmission facilities	X		
	Materials for makeshift (emergency restoration construction, installation of temporary telecommunication lines, electric power supply)	X		
	Emergency restoration equipment (outdoor line trunk accommodation units, temporary repeater)	X		Back up repeaters
	Movable and deployable ICT resource units	X		Non-operational
Fixed access and terminal equipment	Special toll-free public phones			N/A
	Satellite mobile phones		X	
	Repurpose resources from other stations (laying in cable from other areas and out-rigging of network facilities)	X		Same standards and same frequency bands
	Underground multipurpose duct of cables		X	
Mobile access and terminal equipment	Large-zone (long reach) mobile base stations	X		10-12 km
	Mobile and compact base stations (including femtocells).	X		Experimentation phase/ongoing project
	Satellite mobile phones		X	
Internet access	Free access to wireless LAN and Internet including in evacuation centres	X		Free access to Wi-Fi and hot spot to users for a few days in the Sud
	Autonomous network construction for continuous communication (delay tolerant networking, local wireless mesh network with portable advanced wireless base station)	X		Modular system/partial network failure
Electric power supply	Power-supply car	X		Capacity: 8-10 Kw/site

Source: AccessHaiti

For the leading ISP, it is noted that 10 out of 16 items are implemented for recovery, and AccessHaiti thus has achieved 62.5 per cent.

Box 4: Recommendations: ISP recovery

Key recommendations
• Improvement of the recovery capacity within three months by acquiring mobile satellite phones for recovery operations management. • Improvement of the recovery capacity within nine months by operationalizing the movable and deployable ICT resource units. • Improvement of the recovery capacity within eighteen months by deploying underground multipurpose duct of cables.

4.5 Business continuity management

Given that telecommunication services are essential within a society, and providers may lose significant revenues following a disaster, strategies and measures must be adopted to ensure that they can still serve users in all circumstances and avoid losses. In this context, the strategies should focus on how they can continue their activities during crises. Business continuity is the capacity of a company to keep the main and essential functions during and after a disaster has occurred.

Business continuity management (BCM), as defined by the ISO 22301:2012 standard, is the "holistic management process that identifies potential threats to an organization and the impacts to business operations those threats, if realized, might cause. It is the provision of a framework for building organizational resilience with the capability of an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities."[27]

GSMA has developed guidelines for MNOs to develop a BCM which is a structure that includes a business continuity plan (BCP).

According to GSMA, the main stages within a BCM are the following:

1) Assessment: MNOs assess risks, including specific vulnerabilities and hazards, internal capacity assessments, impact evaluation and criticality determination. This assessment helps to identify focus areas for planning and resourcing.
2) Planning: based on the requirements identified in the assessment, create a BCP to restore and maintain the business in times of crisis.
3) Action/build: implement the BCP within the organization and with key stakeholders (e.g., energy suppliers, see section 8), identify and train key staff and develop processes.
4) Simulate/test: regular simulations are needed to test BCPs. This should be a mix of internal and external simulations with relevant government authorities and humanitarian responders.
5) Update: regularly review and update the BCP based on lessons from simulations or actual experiences. The BCP should be tested using an iterative approach.[28]

As part of a BCM, the BCP must be developed to help prevent interruptions in the operations of a company. The BCP consists of two components: proactive measures and reactive measures. Proactive measures are developed to prevent the interruption of company activities, while

[27] ISO 22301 : Business Continuity, available at: https://www.iqnet-ltd.com/en/our-portfolio/business-continuity.
[28] Building a Resilient Industry: How Mobile Network Operators Prepare for and Respond to Natural Disasters available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/03/TWP5861_BuildingAResilientIndustry_v003.pdf.

reactive measures assist the company to recover from a disaster. All the MNOs operating in the Haiti market should consider the GSMA guidelines to strengthen their existing BCM.

4.6 Overall assessment of the recovery plans

The restoration capacity is vital to telecommunication networks in the aftermath of a disaster. When disasters strike, there might be telecommunication failure because of physical destruction of network components, disruption in supporting network infrastructure and network congestion.

The availability of substitute or redundant elements in a network and repair equipment are a key components in the restoration process of service. In that regard, it is recommended that the mobile operators and the ISPs are equipped for the four phases of restoration:

- emergency responses;
- restoration and repair;
- reconstruction of the destroyed infrastructure for functional replacement; and
- reconstruction for redevelopment.

An efficient recovery plan must include, among others:

- substitute network and repair equipment;
- pre-positioned teams;
- capacity of rapid interventions;
- restoration of quality of service;
- renewal of repair equipment; and
- reconstruction strategies.

The existing recovery plan of the telecommunication services providers of Haiti depends on two factors:

- Substitute network and repair: the majority of vital components for repair and reconstruction are available. By a simple analysis of the questionnaires answered, the capacity to recover or reconstruct varies from 60 to 75 per cent. The ability and the level of preparedness of an MNO to restore the service in less than one day is a good capacity of adaptation.
- Strategies of intervention: The strategies to access the affected areas are excellent. The providers pre-position teams who can reach the areas for quick interventions.

The mobile operators and the ISP are equipped for the four phases of restoration:

- emergency responses;
- restoration and repair;
- reconstruction of the destroyed infrastructure for functional replacement; and
- reconstruction for redevelopment.

The reconstruction of destroyed infrastructure is necessary for immediate restoration of service, with a strategy to rebuild infrastructure for a better redeployment in order to be able to cope efficiently with future disasters. However, the global recovery plan needs to be improved significantly because there is a huge disparity between operators. It is important to note that one mobile operator has 30 cell sites on wheel (COW) available to be deployed at any time and any location, while the other mobile operator and the ISP has none.

Radio and TV stations must order their equipment and materials from abroad for recovery and reconstruction purposes. This process may take weeks. Their supporting infrastructure (power, building) are also vulnerable.

4.7 Disaster connectivity map (DCM)

In order to help the first responders, ITU and Emergency Telecommunications Cluster (ETC) have developed the Disaster Connectivity Map (DCM) tool (supported by GSMA Mobile for Humanitarian Innovation programme), a mapping platform that helps determine the status of telecommunication network infrastructure, coverage, and performance before and after a disaster. The information provided by the DCM can be used for decision-making regarding the areas where telecommunication services need to be restored. ITU hosts DCM maps. The DCM provides three types of information on telecommunication networks:

1) network infrastructure: physical features such as terrestrial fibre-optic links, microwave network links, submarine cables, and mobile cell sites;
2) mobile network coverage: projected and/or actual mobile network coverage;
3) connectivity performance: metrics such as ping, latency, throughput (download/upload).

The DCM data comes from different sources. Based on the information available, network coverage and performance information will be dynamically updated in DCM using near real-time data. This tool is very important for local authorities and the telecommunication service providers. The emergency services will discover areas where services are unavailable; and the operators will be able to identify areas in which to intervene first for the restoration of service. Taking into account the valuable information this dynamic map can provide, DCM would be invaluable to telecommunication operators and civil protection and emergency services managers during and after disasters.[29]

[29] Disaster Connectivity Map is available at: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Disaster-Connectivity-Maps.aspx.

5 Telecommunication networks and infrastructure resilience

5.1 Resilience assessment methodology

Resilience can be assessed at two levels:

- operator resilience (MNOs, ISPs and broadcasters);
- country-level resilience.

The resilience of a system is its ability to continue providing service at an acceptable level despite disruption caused by damage. Questionnaires were used to collect data to measure the ability of telecommunication service providers to withstand damage and recover from a disruption of service. Specific questionnaires for each type of network or system covered the resilience capacity of all parts of the network and infrastructure including radio and TV broadcasting. The country-level resilience assessment was based on the following parameters: infrastructure, performance, security and market readiness. The resilience assessment process was completed by interviews with the regulator and operators, as well as the leading technical managers of radio and television stations, and Internet components (Internet Exchange Point (IXP), domain .ht).

5.2 Basic features of a resilient telecommunication infrastructure

The resilience of telecommunication networks and infrastructure is not purely a technical solution. It is a set of elements that need to fully cooperate in a timely manner in order to make the system capable of withstanding disasters. Resilience is required for businesses to respond to disruptions as well as positively adapt in the face of challenging conditions, leveraging opportunities and delivering sustainable performance improvement.[30] Resilience of telecommunication networks and infrastructure can be considered in three levels:

- Passive resilience is the ability of an organization to return to its original state after being subjected to a shock to reduce losses.[31] This type of resilience relies on the availability of equipment and a well-designed architecture.
- Active resilience is a set of proactive activities that organizations must undertake to adapt to adversity and turbulence.[32]
- Organizational resilience is the ability of an organization to anticipate, prepare for, respond and adapt to incremental change and sudden disruptions in order to survive and prosper.[33] It may consist of pre-positioning equipment and teams to react in time and provide temporary solutions.

From a technical point of view, network resilience is strictly related to network autonomy, dependability and connectivity. In addition, a resilient network infrastructure is required to provide security, availability, maintenance of performance, and business continuity.[34] According

[30] Organizational Resilience is available at: www.crandfield.ac.uk.
[31] Mieux comprendre la résilience active et passive par le cycle de vie de la crise en tant qu'élément de temporalité, available at : http://www.resilience-organisationnelle.com/1/upload/mieux_comprendre_la_ra_silience_active_et_passive_par_le_cycle_de_vie_de_la_crise_en_tant_qua_a_la_ment_de_temporalita_.pdf.
[32] Idem.
[33] Organizational Resilience is available at: www.crandfield.ac.uk.
[34] Enabling and managing end-to-end resilience available at: http://www.enisa.europa.eu/act/it/eid.

to the European Network and Information Security Agency (ENISA), the basic features of resilient telecommunication infrastructure include:

- No single point of failure: It must address all areas of network equipment such as switches, and routers, and transmission interconnections between these elements, both on a local area and wide area basis.
- In-built failover: The failure of an element brings about a changeover to a standby working element or load sharing, such that the failure of a single element within a group of similar elements does not cause degradation of service. As with network elements, the transmission interconnections between them must also operate on a failover or load-sharing basis.
- Sufficient capacity: Sufficient capacity in both network elements and transmission interconnections (both signalling and media) allows for known peak demand plus a degree of 'headroom' which will allow for unexpected peaks in traffic beyond the norm.
- Resilient ancillary services: Examples are DNS servers and other ancillary network elements that enable the transmission of network traffic as opposed to those network elements that carry network traffic.
- Resilient network monitoring and management systems: These systems allow network engineers to identify and rectify problems in an efficient manner. This also implies a degree of resilience of the network monitoring and management centres that house these systems.
- Resilience from the support infrastructure: Support infrastructure is in terms of network engineering staff who plan and implement changes and who identify and correct problems, and of call centre staff who handle fault calls from users or customers and pass these onto the network engineering staff for fault diagnosis and repair.
- Physical locations: Where network equipment is housed, the power supplies which keep the equipment in operation, the cooling systems which maintain suitable environmental levels, and the physical and electronic security systems which ensure that network equipment is safe from physical or electronic attack either from within or outside the organization.[35]

Resilience is based on an operational culture within any company. This operational culture is linked to policies, procedures and vigilance that include:

- Compliance: The ability to meet regulatory requirements, including those for transparency and data availability.
- Continuity and recovery: The ability to keep the business processes up and running and to support customers and business partners while managing unexpected events.
- Security and privacy: The ability to protect the business, information and customer data from external attack or internal breaches.
- Scalability: The ability to adjust systems as business changes and grows.[36]

5.3 Requirements for telecommunication networks resilience

In this section, the requirements of the ITU-T focus group on disaster relief systems, network resilience and recovery will be used to assess the level of resilience of each network.[37]

---

[35] Enabling and managing end-to-end resilience available at: http://www.enisa.europa.eu/act/it/eid.
[36] Idem.
[37] Requirements for Network Resilience and Recovery, ITU-T focus group on disaster relief systems, network resilience and recovery, May 2014, available at: https://www.itu.int/en/ITU-T/focusgroups/drnrr/Pages/default.aspx.

The assessment of network resilience verifies the availability of the following technical capabilities: redundancy and congestion control. This assessment also takes into account six main components: satellite, core network, fixed access and terminal equipment, mobile access and terminal equipment, Internet access and electric power supply. The availability and the activation capability of the critical elements are assessed within each operator. Buildings that are compliant with geo-seismic standards are very important in the framework of resilience assessment. Table 17 assesses the level of resilience of each operator.

Table 17: Network resilience

Parts of the network	Item
Satellite	Portable earth station to reach the satellite
	Mobile base station with satellite entrances
Core network	Spares for switching equipment and transmission facilities
	Multiple routes of transmission facilities
	Installation of fault detection device
	Installation of congestion detection and traffic control function
	Installation of automatic fire alarms and extinguisher systems
	Secure facilities to a stable structure robust against collapse
	Stable outdoor facilities and solid building to ameliorate effects of disasters
	Increase in switching capacity
	Emergency priority voice calls
	Flexible allocation of network resources (including relevant processing resources)
Fixed access and terminal equipment	Offload voice calls to other media (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)
	IP phones
Mobile access and terminal equipment	Offload of voice calls to other means (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)
	Mobile IP phones
	Sending SMS over the data transmission network
Internet access	Increase in line capacity for ensuring Internet connectivity
	Bandwidth control
	Distributed Internet exchanges (IXs) and data centres over a wider geographical area
	Mirror sites
	User experience improvement with unstable or intermittent network connectivity

Table 17: Network resilience (continued)

Parts of the network	Item
Electric power supply	Spare power supply
	Backup generators or batteries

Source: ITU

5.4 Redundancy and congestion control assessment

Network and infrastructure resilience relies on redundancy and congestion control during any failure due to disaster and/or a spike in traffic. It is crucial to assess the availability of redundant equipment and congestion control functions of each operator. Tables 18, 19 and 20 reflect fundamental aspects of resilience including other non-dependent telecommunication systems such as portable earth stations and mobile base stations with satellite access. In addition, recommendations relative to each questionnaire are shown in boxes 5, 6 and 7.

Network resilience: Digicel

Preparedness before disaster and response and relief during disaster (redundancy and congestion control)

Table 18: Questionnaire 4: Digicel

Parts of the network	Item	Yes	No	Comments
Satellite	Portable earth station to reach the satellite		X	N/A
	Mobile base station with satellite entrances		X	N/A
Core network	Spares for switching equipment and transmission facilities	X		
	Multiple route of transmission facilities	X		
	Installation of fault detection device	X		
	Installation of congestion detection and traffic control function	X		
	Installation of automatic fire alarms and extinguisher systems	X		
	Secure facilities to a stable structure robust against collapse	X		
	Stable outdoor facilities and solid building to ameliorate effects of disasters	X		
	Increase in switching capacity	X		
	Emergency priority voice calls		X	
	Flexible allocation of network resources (including relevant processing resources)	X		Modular systems

Table 18: Questionnaire 4: Digicel (continued)

Parts of the network	Item	Yes	No	Comments
Fixed access and terminal equipment	Offload voice calls to other media (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)	X		
	IP phones	X		
Mobile access and terminal equipment	Offload of voice calls to other means (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)	X		
	Mobile IP phones		X	
	Sending SMS over the data transmission network	X		
Internet access	Increase in line capacity for ensuring Internet connectivity	X		
	Bandwidth control	X		
	Distributed Internet exchanges (IXs) and data centres over a wider geographical area		X	
	Mirror sites	X		
	User experience improvement with unstable or intermittent network connectivity	X		
Electric power supply	Spare power supply	X		
	Backup generators or batteries	X		

Source: Digicel

Digicel has an availability of 19 out of 24 items of the resilience questionnaire, and Digicel achieved 79.16 per cent.

Box 5: Recommendations: Resilience MNO1

Key recommendations
Improvement of the resilience level within three months by deploying mobile IP phones. Improvement of the resilience level within nine months by: • setting up emergency priority voice calls; • distributing Internet exchange and data centres in different strategic locations.

Network resilience: Natcom

Preparedness before disaster and response and relief at and during disaster (redundancy and congestion control)

Table 19: Questionnaire 4: Natcom

Parts of the network	Item	Yes	No	Comments
Satellite	Portable earth station to reach the satellite		X	
	Mobile base station with satellite entrances		X	
Core network	Spares for switching equipment and transmission facilities	X		
	Multiple route of transmission facilities	X		
	Installation of fault detection device	X		
	Installation of congestion detection and traffic control function	X		
	Installation of automatic fire alarms and extinguisher systems	X		
	Secure facilities to a stable structure robust against collapse	X		
	Stable outdoor facilities and solid building to ameliorate effects of disasters	X		
	Increase in switching capacity	X		
	Emergency priority voice calls	X		
	Flexible allocation of network resources (including relevant processing resources)	X		
Fixed access and terminal equipment	Offload voice calls to other media (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)	X		
	Fixed IP phones		X	
Mobile access and terminal equipment	Offload of voice calls to other means (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)	X		
	Mobile IP phones		X	
	Sending SMS over the data transmission network		X	
Internet access	Increase in line capacity for ensuring Internet connectivity	X		
	Bandwidth control	X		
	Distributed Internet exchanges (IXs) and data centres over a wider geographical area	X		
	Mirror sites		X	
	User experience improvement with unstable or intermittent network connectivity	X		

Table 19: Questionnaire 4: Natcom (continued)

Parts of the network	Item	Yes	No	Comments
Electric power supply	Spare power supply	X		
	Backup generators or batteries	X		

Source: Natcom

Natcom reported 18 out of 24 items of the resilience questionnaire as available, and Natcom achieved 75 per cent.

Box 6: Recommendations: Resilience MNO2

Key recommendations
Improvement of the resilience level within three months by: • developing mirror sites; • improving the level of connectivity during disaster. Improvement of the resilience level within nine months by: • setting up emergency priority voice calls; • distributing Internet exchange and data centres in different strategic locations; • deploying fixed IP phones.

Network resilience: AccessHaiti

Preparedness before disaster and response and relief at and during disaster (redundancy and congestion control).

Table 20: Questionnaire 4: ISP

Parts of the Network	Item	Yes	No	Comments
Satellite	Portable earth station to reach the satellite		X	N/A
	Mobile base station with satellite entrances		X	N/A

Table 20: Questionnaire 4: ISP (continued)

Parts of the Network	Item	Yes	No	Comments
Core network	Spares for switching equipment and transmission facilities	X		
	Multiple route of transmission facilities	X		Microwave back up
	Installation of fault detection device	X		Multiple alerting system: 1. email, 2. Indicator light, 3. Software
	Installation of congestion detection and traffic control function	X		For the customers in the nodes
	Installation of automatic fire alarms and extinguisher systems	X		
	Secure facilities to a stable structure robust against collapse	X		Experiences with the last disasters in the current building Reinforcement in the main transmission site
	Stable outdoor facilities and solid building to ameliorate effects of disasters	X		Rooftop sites – no guarantee for all
	Increase in switching capacity		X	Packet forwarding
	Emergency priority voice calls		X	N/A
	Flexible allocation of network resources (including relevant processing resources)	X		Standardized network – any part can be used anywhere in the network
Fixed access and terminal equipment	Offload voice calls to other media (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)			Packet forwarding
	IP phones		X	In routing phase from SS7 to SIP

Table 20: Questionnaire 4: ISP (continued)

Parts of the Network	Item	Yes	No	Comments
Mobile access and terminal equipment	Offload of voice calls to other means (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications)		X	N/A
	Mobile IP phones		X	In preparation/ ongoing project
	Sending SMS over the data transmission network		X	N/A
Internet access	Increase in line capacity for ensuring Internet connectivity	X		Flexible/ programmable
	Bandwidth control	X		In preparation/ ongoing project
	Distributed Internet exchanges (IXs) and data centres over a wider geographical area	X		N/A
	Mirror sites	X		Cloudfair
	User experience improvement with unstable or intermittent network connectivity	X		Redundancy
Electric power supply	Spare power supply	X		
	Backup generators or batteries	X		

Source: AccessHaiti

AccessHaiti, the leading ISP, has implemented 15 out of 24 items of the resilience questionnaires and has achieved 62.5 per cent.

Box 7: Recommendations: Resilience ISP

Key recommendations
• Improvement of the resilience level within nine months by deploying mobile IP phones.

5.5 Resilience indicators assessment

In this part, an assessment will be performed for each operator for the following indicators. The results are reflected in tables 21, 22 and 23, and , recommendations are shown in Box 8

- physical infrastructure availability;
- physical infrastructure stability;
- quality of service of the network;
- stability of the network;
- availability of Internet service components; and
- performance of Internet service components.

Digicel

Table 21: Questionnaire 5: Digicel

Physical infrastructure availability		
Item	Availability	Comments
Power stations	X	Generators (1+1) (based on importance) 5 generators in the data centres
Undersea cable	X	Operational under international standards
Terrestrial optical fibre	X	Operational in good conditions
Landing stations	X	1 landing station Based at Kaliko (Montrouis) Operations under international standards
Last mile access networks	X	2G, 3G, 4G LTE, FTTH and Point to point link for companies

Physical infrastructure stability		
Item	**Stability**	**Comments**
Power stations	X	Affected in few areas
Undersea cable	X	Operational under international conditions
Terrestrial optical fibre	X	Good Subject to damage due vandalism (unfavourable environment)
Landing stations	X	Operational under international conditions
Last mile access networks	X	Good Subject to damage due vandalism (unfavourable environment)

QoS of the Network		
Item	**QoS**	**Comments**
Reachability	X	Excellent Possible cable cut off at any time due to vandalism
Throughput	X	High speed availability
Latency to select target servers	X	1millisecond to reach Facebook, Netflix and Google servers

Stability of the network		
Item	Stability	**Comments**
Reachability	X	Stability guaranteed in areas covered
Throughput	X	Good stability

(continued)

Stability of the network		
Item	Stability	Comments
Latency to select target servers	X	Very stable

Availability of Internet service components		
Item	Availability	Comments
DNS ecosystem	X	Operational in good condition Unavailability of DNSSEC for TLDs
Intrusion detection systems	X	Good firewalls to detect bad traffic

Performance of Internet service components		
Item	Perfor-mance	Comments
DNS ecosystem	X	Excellent performance guaranteed
Intrusion detection systems	X	Excellent efficiency

Source: Digicel

Natcom

Table 22: Questionnaire 5: Natcom

Physical infrastructure availability		
Item	Availability	Comments
Power stations	X	Generator (1+1) + back up (City power + Generator+ solar panel) for all BTS 2 generators for the data centre
Undersea cable	X	Very secure
Terrestrial optical fibre	X	Secure
Landing stations	X	3 landing stations 1) Kaliko (Montrouis) 2) BTC (Grand'Rue) 3) Claro (Malpasse) Operational under international standards
Last mile access networks	X	2G, 3G, 4G LTE, FTTH

Physical infrastructure stability		
Item	Stability	Comments
Power stations	X	Good stability Possible disruptions at any time due to unfavourable environment (community distur-bance)

(continued)

Physical infrastructure stability		
Item	Stability	Comments
Undersea cable	X	Operational under international standards
Terrestrial optical fibre	X	Excellent stability
Landing stations	X	Operational under international standards
Last mile access networks	X	FTTH Possible cut off due to vandalism (in unfavourable environments)

QoS of the Network		
Item	QoS	Comments
Reachability	X	Range: 80% – 100%
Throughput	X	Availability of High speed
Latency to select target servers	X	50 microsec – 1milsec to reach most of the servers

Stability of the network		
Item	Stability	Comments
Reachability	X	Good in areas covered
Throughput	X	Very good stability for the speed offered
Latency to select target servers	X	Stability guaranteed

Availability of Internet service components		
Item	**Availability**	**Comments**
DNS Ecosystem	X	Operational in good condition Unavailability of DNSSEC for TLDs
Intrusion detection systems	X	Availability of efficient alarm systems for trouble shooting

Performance of Internet service components		
Item	**Performance**	**Comments**
DNS Ecosystem	X	Performance range: 95% – 100%
Intrusion detection systems	X	Operational in excellent condition (100%)

Source: Natcom

AccessHaiti

Table 23: Questionnaire 5 ISP

Physical infrastructure availability		
Item	Availability	Comments
Power stations	X	Generators and City power from public electrical power grid in back up
Undersea cable	X	2 submarine cables
Terrestrial optical fibre	X	Aerial optical fibre – redundancy via ring
Landing stations	X	2 landing stations 1) Kaliko (Montrouis) 2) Grand'Rue (Port-au-Prince) Operational under international standards
Last mile access networks	X	FTTH – Point to Multipoint 4G/LTE – Radom/ubiquity radom

Physical infrastructure stability		
Item	Stability	Comments
Power stations	X	Good stability Possible disruptions at any time due to unfavourable environment (community disturbance)
Undersea cable	X	Operational under international standards
Terrestrial optical fibre	X	Excellent stability
Landing stations	X	Secure locations
Last mile access networks	X	FTTH Possible cut off due to vandalism (unfavourable environment)

QoS of the Network		
Item	QoS	Comments
Reachability	X	Good in areas covered
Throughput	X	High speed
Latency to select target servers	X	280 ms to NAP (USA); 1ms to Boutilliers (cache servers)

Stability of the network		
Item	Stability	Comments
Reachability	X	Good in areas covered
Throughput	X	Good stability for the speed offered

(continued)

Stability of the network		
Item	Stability	Comments
Latency to select target servers	X	Very stable

Availability of Internet service components		
Item	Availability	Comments
DNS ecosystem	X	Operational in good condition Unavailability of DNSSEC for TLDs
Intrusion detection systems	X	Availability of firewalls

Performance of Internet service components		
Item	Perfor-mance	Comments
DNS Ecosystem	X	Excellent performance under the existing operating conditions
Intrusion detection systems	X	Use of firewall/Fortinet/Fortiget/ to filter unwanted traffic

Source: AcccessHaiti

Box 8: Recommendations: Resilience indicators

Key recommendations
• Improvement of the resilience indicators within three months by reinforcing the physical protection of landing stations. • Improvement of the resilience indicators within nine months by protecting infrastructure against vandalism and theft.

5.6 Internet exchange point (IXP), ccTLD and ISP market resilience assessment

From an operational point of view, the ISP market was assessed based on the data provided by the ISPs, and two high level technical managers: Mr. Max Larson Henry, current President of AHTIC, and Mr. Reynold Guerrier, former President of AHTIC, and CEO of IT and Statistics Support Group (GSIS).

There is one IXP for all mobile operators and ISPs for local Internet traffic. This IXP is based at Boutilliers in secure facilities. Boutilliers is also the transmission site for most of the radio and TV stations broadcasting in the western department. This is a neutral location, as is required for such technical infrastructure. There are backup generators to ensure smooth and continued operations of all components of the IXP and the cooling systems. There is redundancy for the switch and routers. There are also back up servers that are based in other locations. The current capacity is sufficient to handle local traffic. It remains available for the connection of new entrants in the market. As the usage of ccTLD (the **.**ht domain) has increased, there is back

up by secondary servers based in Canada and France. It is also hosted at Boutilliers in secure facilities. Tables 24 to 26 give further details on IXP and the local peering fabric.

Presence and efficiency of IXP

Table 24: Questionnaire 6: IXP

Item	IXP	Comments
Presence	X	Operational under international requirements
Efficiency	X	Excellent efficiency for all ISPs

Presence and efficiency of local peering fabric

Table 25: Questionnaire 7: Local peering

Item	Local peering fabric	Comments
Presence	X	Operational under international requirements
Efficiency	X	Excellent efficiency for all ISPs

This table provides data on the market resilience from an operator perspective. Only 37 per cent of the population uses Internet directly in Haiti, and few local contents are available online. There are several barriers to the development of the Internet market in Haiti.

Table 26: Questionnaire 8: ISP market

ISP Market Resilience Assessment			
Criteria	Yes	No	Comments
Availability of IXP	X		Established since 2009 – connection of all ISPs – operational in standard condition
Efficiency of IXP	X		Excellent performance
Traffic Localization		X	Availability of a few content servers in Haiti to manage the local traffic locally
Self-regulation	X		Current trends: Cost reduction, promotion of compliance (e.g., use of DNSSEC), less intervention from government/ regulator
Affordability	X		Multiple data plans available: 1) different types of monthly data plans + voice 2) different types of weekly voice and data plans + voice 3) different types of daily data plans + voice Weekly and daily plans based on the allocation of a quantity of GB and minutes

5.7 Redundancy plans

In countries like Haiti, where multiple disasters can occur, it is imperative for operators to consider strategic redundancy plans. To do so, key sites must be identified to be allocated redundant capacities. The redundancy measures should encompass:

- Service duplication: Operators should implement running systems that mirror each other in different locations, and if one system fails, the other can take over.
- Geo-redundancy: Operators should ensure that sites that are far apart geographically and can take over the load of another in the event of a failure.[38]

5.8 Traffic overload management plans

Strong traffic overload is a cause of network congestion. A too high level of congestion will result in network failure. In order to avoid this worst scenario, and to continue serving the users, a set of measures can be taken to manage the increase in traffic resulting from the disaster. The following measures can be used to manage increased traffic:

- Overload handling: The network should procure redundant capacity to cope with system overload. It is convenient to deploy extra capacity in key sites.
- Backup and reinforcement: Cell on wheels (COW), cell on light truck (COLT), drone backpacks can be deployed in areas where a sudden peak of traffic is observed. This process provides backup and reinforcement when needed.
- Network traffic management plan and prioritization: During emergency situations, it is imperative to prioritize key messages, such as early warning alerts or messages to the population. Promotion and marketing messages, and even normal user traffic should be processed after key messages.
- Customer awareness of best practices following disasters: It is important to launch an awareness campaign to encourage users to text instead of calling. This strategy can significantly reduce traffic during emergency situations.
- Prioritization of data or voice traffic depending on availability: Based on the communication channels available, MNOs can prioritize channels that will be more accessible to the population. For example, if a data-based public message board is being used, MNOs can prioritize data to ensure people can access it.[39]

5.9 Power systems resilience assessment

The availability and reliability of electrical power supply are essential to the operations of telecommunication networks and infrastructure. Telecommunication systems can be fed by the commercial power grid, independent providers, or private systems such as generators and renewable energy. In remote areas, it is common for operators to have their own power systems due to the limitation of the commercial power grid.

When commercial power outages occur after a natural disaster, huge impacts can be seen on MNO operations. In some cases, the networks and infrastructure are left undamaged after a disaster, while the power systems may have suffered huge disruptions or damages; this situation

---

[38] Building a Resilient Industry: How Mobile Network Operators Prepare for and Respond to Natural Disasters available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/ 2020/03/TWP5861_BuildingAResilientIndustry_v003.pdf.

[39] Building a Resilient Industry: How Mobile Network Operators Prepare for and Respond to Natural Disasters available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/03/TWP5861_BuildingAResilientIndustry_v003.pdf.

will result in an unavailability of service due to the absence of electrical power. In order to guarantee the continued operations of the network, it is essential to have backup power systems, and a sufficient stock of fuel to operate backup systems. In Haiti, most of the electric power is provided by the operators themselves because of the low capacity of the commercial power grid.

For the critical and sensitive parts of the networks, up to five power generators are available to ensure continuity of service in the event of failure. The operators install generators and renewable energy systems to feed base stations deployed throughout the country. For the continued running of the generators, operators of telecommunication pre-position and manage the stock of fuel in strategic locations in the regions.

The renewable energy systems composed of solar panels and batteries are mostly used during daylight due to their low capacity. Those power systems are being trialled in rural areas where the infrastructure deployed require less power.

Table 27: Power systems assessment

Item	Yes	No	Comments
Backup systems (generators/power banks)	X		Used by all of them
Generators on wheel	X		Used by two of them
Strategic fuel stock	X		All MNOs and ISP have their own
Renewable energy	X		Used in rural areas by all
Reduction of battery consumption of backup power sources (prioritization of networks bands - 4G / 2G)			No information available on this

Based on Table 27, it appears that the MNOs and the leading ISP have redundancy for their power systems. It is also important for the operators to consider the need to reduce consumption during emergency situations by prioritizing one network band, either 4G or 2G.

Box 9: Recommendations: Resilience power systems

Key recommendations
Improvement of the power systems resilience level within three months by: • acquiring generators on wheels; • checking regularly the backup power supplies; • prioritizing power supply and fuel distribution. Improvement of the resilience level within nine months by: • installing renewable energy for all relevant BTS; • coordinating with equipment vendors to ensure power supply technologies are up to date and power consumption is minimized.[40]

[40] Building a Resilient Industry: How Mobile Network Operators Prepare for and Respond to Natural Disasters available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/03/TWP5861_BuildingAResilientIndustry_v003.pdf.

5.10 Broadcasting sector resilience assessment

Haiti has 347 FM radio stations and 131 terrestrial TV stations that cover different areas of the country. A few of them have national coverage because of the restriction of the current legal framework and a lack of infrastructure. Many of the broadcasting stations operating in the areas affected by the last earthquake were either damaged or completely destroyed. A percentage of the radio and TV stations damaged or destroyed have been restored or rebuilt to resume normal activities.

The following tables reflect the current situation of the broadcasting sector, based on interviews with two leading technical managers of most of the radio and TV stations: Mr. Fritz Joassin, Chairman and CEO of Electrocom S.A. et Satelcom Haïti Wireless, and Mr. Yvon Auguste, technical Director of National Television of Haiti.

Broadcasting sector restoration plan

Table 28: Questionnaire 8: Broadcasting restoration

Parts of the network	Item	Yes	No	Comments
Studio transmitter link (STL)	Spares for STL facilities (transmitter, cables, antennas, towers)	X		Only for few of them
	Materials for makeshift (emergency restoration construction, installation of temporary telecommunication lines, electric power supply)	X		Only for few of them
Broadcasting system	Spare broadcasting equipment (Transmitter, Antennas, Cables, Tower)	X		Only for few of them
	Materials for makeshift (emergency restoration construction, installation of temporary telecommunication lines, electric power supply)	X		Only for few of them
Electric power supply	Power-supply car		X	Only for few of them

The following table presents the current level of resilience of the broadcasting sector.

Broadcasting sector resilience

Table 29: Questionnaire 9: Broadcasting resilience

Parts of the network	Item	Yes	No	Comments
Studio transmitter link (STL)	Spares for STL facilities (transmitter, cables, antennas, tower)	X		Only for few of them
	Multiple routes of transmission facilities		X	Only for few of them

Table 29: Questionnaire 9: Broadcasting resilience (continued)

Parts of the network	Item	Yes	No	Comments
Broadcasting system	Spare broadcasting equipment (Transmitter, Antennas, Cables, tower)	X		Only for few of them
	Multiple routes of transmission facilities		X	No satellite broadcasting
Electric power supply	Spare power supply	X		Only for few of them
	Backup generators or batteries	X		Only for few of them
Secure facilities	Studio building	X		Only for few of them
	Transmitter building	X		Only for few of them
	Installation of automatic fire alarms and extinguisher systems	X		
	Stable outdoor facilities and solid building to ameliorate effects of disasters	X		Only for few of them

Given the importance of the broadcasting sector before, during and after disasters, necessary measures should be considered to help the radio and TV stations play their roles to the benefit of the population. As part of the emergency telecommunication chain, the broadcasting sector needs to be reinforced at four levels: studio transmitter link (STL), broadcasting system, electrical power supply and facilities, as it is the simplest way to reach the target population, especially with early warning messages.

The absence of a substitute network and the lack of spare parts in the market will cause delay in their post-disaster recovery. The extent of the damages of the earthquake on the radio and TV stations showed a low level of resilience.

Box 10: Recommendations: Recovery - resilience broadcasting

Key recommendations

Improvement of the resilience level within three months by:

- acquiring spares for STL and broadcasting system;
- putting in place electric power supply back up.

Improvement of the resilience level within nine months by:

- reinforcing studio and transmission sites building and facilities;
- implementing multiple routes for STL;
- implementing infrastructure sharing.

5.11 Overall assessment of the MNOs and ISP resilience

The ability of a network to maintain an acceptable level of service in the event of an outage or during disasters relies on four pillars:

- Redundancy: Availability of extra capacity to be activated for the return to normal operations in the event of technical failures, or duplication of the existing systems to take over in the event of a failure.
- Route diversity: Availability of several physical paths for the routing of communication between two points, while avoiding a single point of failure.
- Protective measures: Capacity of decreasing the likelihood of threat to affect the network.
- Restorative measures: Capacity of enabling rapid restoration in case of service disruption or congestion (congestion control function is activated in case of increase of call volume in response to a disaster, and to control the resulting traffic).

Resilient networks should be designed bearing in mind at least the following issues: availability, fault tolerance at the node level and redundancy at the topology level.[41] Based on the answers provided in the questionnaires, and those received during interviews, the overall level of resilience is above average, but it needs to be completed. The main components required for resilient networks and infrastructure indicated in the questionnaires are available to operators.

The overall resilience of the Haiti telecommunication market varies from 60 per cent to 80 per cent. Two out of three service providers have three international access points, the other has only one and urgently needs to put in place one or two more international access points for resilience purposes. It benefits from a partial redundancy from the same landing station through Cap Haitian, in the northern region of the country.

Major towns are protected by a fibre-optic ring as well as microwave links. One operator still needs to complete the ring resilience for several towns. In some cases, there is a combined resilience: the operational backbone relies on optical fibre, while the backup link is via microwave links.

It is important to note that in countries where multiple types of disasters occur, it can be challenging to select a network infrastructure that is resilient to all risks. All telecommunication operators have to face those difficult choices when it comes to choosing the architecture and equipment to build resilient networks in such environments.

[41] European network and information security agency (Enisa) available at: http://www.enisa.europa.eu/act/it/eid.

Box 11: Recommendations: MNO/ISP

Key recommendations

Improvement of the resilience level within three months by:

- reinforcing physical security rooftop base stations;
- coordinating with the Ministry of Public Works before the deployment of underground and aerial cables (telecommunication infrastructure, particularly, underground and aerial cables, may suffer damages at the construction of roads and bridges, therefore, coordination is needed to avoid destruction and disruptions);
- launching an awareness campaign for the population for the protection of infrastructure.

Improvement of the resilience level within nine months by:

- distributing Internet exchange and data centres in different strategic locations;
- implementing infrastructure sharing.

Improvement of the resilience level within eighteen months by:

- implementing underground deployment of cable for protection against damage and vandalism;
- deploying submarine cable for the coastal cities;
- establishing redundancy for international gateway (at least for one operator);
- combining redundant channels (optical fibre, satellite, microwave) to reinforce backhaul;
- building large range or umbrella base stations in key areas.

Improvement of the resilience level in the long term by implementing virtualized networks (transition from highly centralized to distributed network).[42]

5.12 MNO and ISP needs

The lack of resilience of mobile operators and ISPs is reflected in their many technical concerns related to the network and infrastructure issues including:

- maritime redundancy for backbones;
- resolution of radioelectric interference (mainly in the northern part, in the border with the Dominican Republic);
- infrastructure sharing;
- national submarine backbone network;
- continued assistance from the regulator;
- awareness campaign for the population on the telecommunication infrastructure and the services (protection of public service); and
- physical security for telecommunication operations.

5.13 Country-level Internet resilience

Connect2Recover methodology[43] defines the requirements for Internet resilience within a country. Internet resilience focuses on the three pillars of network/ISP resilience, critical

[42] Building a Resilient Industry: How Mobile Network Operators Prepare for and Respond to Natural Disasters available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/03/TWP5861_BuildingAResilientIndustry_v003.pdf.

[43] Connect2Recover: A methodology for identifying connectivity gaps and strengthening resilience in the new normal is available at: https://www.itu.int/hub/publication/d-tnd-04-2021/.

infrastructure resilience, and market resilience, which include infrastructure, performance, security and market readiness:

- Infrastructure: The existence and availability of the physical infrastructure that provides Internet connectivity. Under this pillar, the following sub-elements must be assessed: exit points, fibre-optic 10 km reach, network coverage, spectrum allocation, data centres, number of IXPs, power availability.
- Performance: The ability of the network to provide end-users with continuous and reliable access to Internet services. The performance of the network will be measured by the following parameters: fixed download, fixed upload, fixed latency, mobile download, mobile upload, and mobile latency.
- Security: The ability of the network to withstand intentional or unintentional disruptions through the adoption of security technologies and best practices. The level of security is assessed by the following parameters: secure web traffic, IPv6 adoption, DNSSEC adoption, DNSSEC validation, mutually agreed norms for routing security (MANRS), DDoS protection, global cybersecurity, secure Internet servers, and security against spam.
- Market readiness: The ability of the market to self-regulate and provide affordable prices to end users by maintaining a diverse and competitive market. Affordability, upstream provider diversity, market diversity, domain count, e-government development index (EGDI), and peering efficiency are the parameters used to measure market readiness.

Chapter four of the Connect2Recover methodology defines the sub elements of each main component that will be assessed for country-level Internet resilience assessment (see Figure 5).

Network/ISP resilience

Network/ISP resilience is based on the following components: link resilience, quality of service, domain name server resilience and intrusion detection:

- Link: A communication channel that connects two or more devices or users for the purpose of signals transmission. A link may be physical or logic. A logic link uses one or more physical links.
- Quality of service: In telecommunications, QoS (quality of service) refers to the ability of a network to meet the requirements for providing a particular type of telecommunication service, particularly in terms of accessibility, availability, continuity and integrity.
- Domain name servers (DNS) are designed to translate domain names into IP addresses; therefore they match website hostnames to their corresponding Internet Protocol or IP addresses.
- Intrusion detection is a mechanism or a system designed to monitor network traffic in order to detect abnormal or suspicious activity on the target being analysed (a network or host).

Critical infrastructure resilience

The critical infrastructure has the following elements: power infrastructure, cable infrastructure, number of IXPs and top level domains.

- Power infrastructure consists of generation, transmission, and distribution elements that are necessary for the electrical supply of other systems.
- Cable infrastructure is a fiber-based network that uses light to transmit signals from one place to another. It may be considered as the last mile connecting the end-users to the network or the national or international link connecting an entire country.
- Internet exchange points (IXP) are an essential part of the technical infrastructure where networks come together to connect and exchange Internet traffic. Therefore, IXPs within

a country is a way of keeping local traffic local. The number of IXPs within a country is an important indicator of the way internet traffic is managed locally.

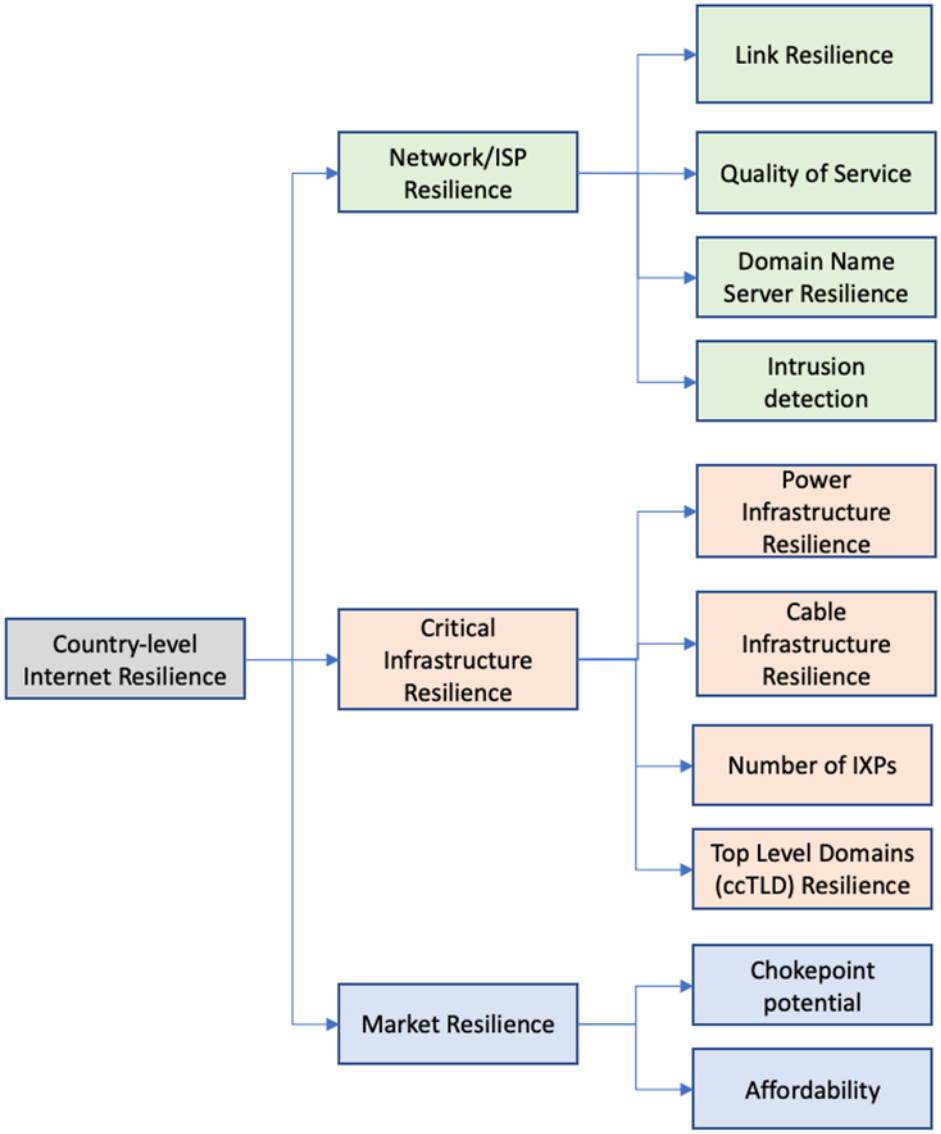
- Top level domain (TLD) is the part of the Uniform Resource Locator (URL) that represents the final section of a domain name. One of the most common top level domains is .com.

Market resilience

Market resilience is composed of the following elements: chokepoint potential and affordability.

- Chokepoint potential is used to measure the level of possible chokepoints in a network within a country in terms of market and spectrum concentration, and the level of coverage diversity (see Appendix B: Formula for chokepoint potential).
- Affordability is the ability of consumers to pay for the services offered. Affordability is based on purchasing power and economic cost.

Figure 5: Hierarchical representation of resilience



Source: Connect2Recover: A methodology for identifying connectivity gaps and strengthening resilience in the new normal, page 35

Table 30: Internet resilience Connect2Recover

Pillar	Dimension	Indicator	Haiti	Rank
Critical infrastructure	Power infrastructure resilience	Power availability[44]	46.9%	
	Cable infrastructure resilience	10 km fibre-optic reach (percent)[45]	Not clear	
		Exit points (Gateways)	Not clear	
	Mobile	Network coverage[46]	70%	
		Spectrum allocation[47]	22.65%	
	Number of IXPs	Number of IXPs	1	
		IXPs per 10 million	0.86	
	Top level domains	Number of ccTLDs[48]	583	
		Number of people per ccTLD	19 726	
		% of apps in local language[49]	35.37%	

[44] Access to electricity (% of population) is available at: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS.

[45] Connectivity in the Least Developed Countries is available at: https://www.itu.int/itu-d/reports/statistics/connectivity-in-the-least-developed-countries-status-report-2021/#:~:text=The%20newly%20launched%20Connectivity%20in,States%20(UN%2DOHRLLS)%2C.

[46] ITU Digital Development Dashboard is available at: https://www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspxdd.

[47] GSMA Mobile Connectivity Index Dimension Scores is available at: https://www.mobileconnectivityindex.com/#year=2019&dataSet=dimension.

[48] Zones Files country code domain list is available at: https://zonefiles.io/cctld-domains/.

[49] GSMA Mobile Connectivity Index Indicator Scores is available at: https://www.mobileconnectivityindex.com/#year=2019&dataSet=indicator.

Table 30: Internet resilience Connect2Recover (continued)

Pillar	Dimension	Indicator	Haiti	Rank
Network/ISP resilience	Link resilience[50]	Peering efficiency (percent ISP peering)	100%	
		Peering efficiency (percent IPs peering)	100%	
	Quality of service[51]	Fixed networks		132
		Fixed latency (ms)	10	
		Fixed upload (Mbit/s)	7.20	
		Fixed download (Mbit/s)	14.12	
		Mobile networks		119
		Mobile latency (ms)	24	
		Mobile upload (Mbit/s)	7.95	
		Mobile download (Mbit/s)	12.49	
	Domain name derver resilience	% of DNSSEC validation by country[52]	63.83%	
		DNSSEC adoption for TLDs[53]	No	
	Cybersecurity/intrusion detection	Secure Internet servers[54]	8	199
		Global cybersecurity Index[55]	6.4	167
		DDOS risks[56]	2	104
		Spams infections	N/A	

[50] Data received from the President of AHTIC.
[51] Ookla country summary is available at: https://www.speedtest.net/global-index.
[52] DNSSEC validation by country is available at: https://stats.labs.apnic.net/dnssec/.
[53] Internet Society Pulse data on DNSSEC adoption for Top Level Domains is available at: https://pulse.Internetsociety.org.
[54] World Bank Secure Internet Servers is available at: data.worldbank.org/indicator/IT.NET.SECR.P6.
[55] ITU Publications https://www.itu.int/epublications/publication/D-STR-GCI.01-2021-HTM-E/.
[56] CyberGreen Stats is available at: https://stats.cybergreen.net/download.

Table 30: Internet resilience Connect2Recover (continued)

Pillar	Dimension	Indicator	Haiti	Rank
Market Resilience	Chokepoint potential[57]	Market concentration for mobile operators	5 413	
		Market concentration for fixed subscriptions	5 800	
		Spectrum concentration	5 200	
	Affordability[58]	Fixed broadband basket as a % of GNI per capita	52.8%	
		Mobile data and voice basket (high consumption) as a % of GNI per capita.	19.5%	
		Mobile data and voice basket (low consumption) as a % of GNI per capita.	18.8%	
		Mobile broadband basket as a % of GNI per capita.	18.5%	
		Mobile cellular basket as a % of GNI per capita.	4.8%	

Critical infrastructure

According to the World Bank, only 46.9 per cent of the Haiti population have access to electricity although access is not always available, nor reliable[59]. This percentage relates to the availability of the infrastructure in some areas rather than the power itself. Telecommunication operators install their own power systems both in cities and rural areas, and this negatively impacts the cost of service for the users. The number of international gateways is unknown, and in addition to the international submarine cables, and the underground cables and microwave links established with the Dominican Republic, there are several satellite television operators, and other organizations that use VSATs.

[57] Calculated using data from operators and CONATEL, and HHI.
[58] ITU Digital Development Dashboard is available at: https://www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspx.
[59] Access to electricity (% of population) is available at: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS.

The percentage of the population living within 10 km fibre-optic backbone is a good indicator of the level of broadband connectivity, and operators in Haiti have started deploying optical fibre, however this deployment is limited to Port-au-Prince and two other big cities. The percentage of people living within 10 km of a fibre-optic network is not available, although ITU data suggests that this is less than 50 per cent.

One IXP serves the whole country having an estimated population of 11.5 million inhabitants. On the base of the number of IXP per 10 million people, Haiti has 0.86 IXP per 10 million people (less than one IXP per 10 million people). This figure places Haiti in the lowest level in the regional and world ranking.

Mobile coverage is not complete in Haiti. Three generations (2G, 3G and 4G) are combined by the two mobile operators. According to an ITU estimate, the country had a global coverage of 70 per cent. The population covered by at least a 3G network is 60 per cent, and the 4G coverage is estimated at 35 per cent. Most of the rural areas are not yet covered by 4G networks. The mobile connectivity index (MCI) calculated in 2020 is 32.8. This index calculated by GSMA is based on four parameters: infrastructure, affordability, consumer readiness, and content and service.

The deployment of infrastructure to increase coverage in Haiti is facing some challenges. Digicel and Natcom are currently sharing the mobile spectrum. Digicel is allocated 169 MHz, while Natcom uses 114 MHz. The spectrum allocation table gives more details concerning the bands used and the quantity of MHz per band for each mobile operator.

Haiti has only 583 .ht country code top level domains (ccTLDs) registered at the Reseau de developpement durable d'Haiti (sustainable development network of Haiti (RDDH)). The .ht domain is used mostly by government institutions and companies, and at a certain level by academic institutions, with only 19 726 people per ccTLD. This situation can be explained by the fact that a large percentage of websites do not use the ccTLD. There is no strong requirement for Haiti websites developed in Haiti to use the ccTLD.

As an overall assessment of critical infrastructure, the scores are not excellent for the Haiti market. Most of the weaknesses concern the deployment of a fibre-optic network for connectivity, electricity and the low rate of adoption of the ccTLD. Significant efforts must be made in the fields of mobile coverage, spectrum management and the Internet exchange point.

Box 12: Recommendations: Resilience infrastructure

Key recommendations
Improvement of the resilience level of critical infrastructure within nine months by: • implementing an optimal frequency management; • creating more contents and applications in the local Haiti language. Improvement of the resilience level of critical infrastructure within eighteen months by: • putting in place two additional IXPs; • reaching a complete coverage of the country; • completing the deployment of 4G networks; • deploying renewable power systems on the rural BTS. Improvement of the resilience level of critical infrastructure in the long term by deploying fibre-optic backbone throughout the whole country.

Network/ISP resilience

The peering efficiency is measured either by the number of ISPs or IP addresses peering at IXPs. Within an IXP, local peering is intended to facilitate exchange of local traffic locally; it is therefore a way to avoid using Internet exit points for local traffic. When the Internet exit points are overloaded, it may result in a chokepoint. The consequence is the decrease of throughput. In the worst case, the service can be made unavailable if the exit point fails.

Haiti has one IXP for four ISPs, and all are peering at the single IXP. The country has 13 Autonomous System Numbers (ASNs).[60] The fact that all ISPs are peering at the IXP is a factor of the importance of resilience for local traffic in the event of a failure in an Internet exit point.

The ookla speedtest data is used to assess the quality of service for networks in Haiti. According to data provided by ookla speedtest for 2022, the fixed and mobile upload speeds are 7.20 Mbit/s and 7.95 Mbit/s respectively, while the fixed download speed is 14.2 Mbit/s, and the mobile download speed is 12.49 Mbit/s. It is noticed that speed values (upload and download) are close, and low compared to those available in other countries. Haiti is ranked 132 out of 181 countries for fixed network, and 119 out 142 for mobile networks. Latencies are 10 ms and 24 ms for fixed and mobile networks respectively and are within the standard levels for high quality telecommunication services, such videoconferencing calls.

Domain Name System Security Extension (DNSSEC) is a standardized protocol that allows the resolution of security issues linked to the DNS. Thanks to its capacity to prevent DNS cache poisoning, this protocol is more and more used throughout the world. According to Apnic, for Haiti, 63.83 per cent of DNS requests are validated by DNSSEC. Haiti performs well in this sense, when considering the current world average is 29.5 per cent, and the average for the Americas region is 34.1 per cent. Haiti does not yet adopt the DNSSEC for top level domains.

According to ITU, the global cybersecurity index of Haiti is 6.4, which is very low. Haiti is ranked 167 out of 182 countries. This indicator needs a significant improvement, as the country is preparing to benefit from digital technologies. Currently, there are only 8 secure Internet servers per 1 million inhabitants. The total secure Internet servers for the whole country is 87, this figure places Haiti among the countries having the lowest numbers of secure servers in the world. With 1 secure Internet server per 1 million people, Haiti is ranked 199th in the world where there are 11 502 secure servers per 1 million people. Haiti has a Distributed Denial of Service (DDOS) attack rate of 2 Tbit/s, and is ranked 104th in the world.

No data is available on the number of spams generated by Haiti.

In terms of network and ISP resilience, Haiti has strengths, weaknesses, and threats. The weaknesses and threats identified include cybersecurity (lack of secure Internet servers and statistics on spams), lack of adoption of DNSSEC for top level domain, and fixed and mobile upload and download speeds. The strengths are in the peering efficiency and rate of validation of requests by DNSSEC, since it performs well for those two indicators.

[60] Regional internet registry statistics available at: https://www-public.imtbs-tsp.eu/~maigron/RIR_Stats/RIR_Delegations/LACNIC/ASN-ByNb.html.

Box 13: Recommendations: Resilience network ISP

Key recommendations
Improvement of the resilience level of network/ISP within three months by: • adopting domain name systems security extension (DNSSEC) for TLDs; • continuing to adopt domain name systems security extension (DNSSEC); • increasing the number of autonomous systems numbers (ASNs). Improvement of the resilience level of network/ISP within nine months by: • using the ITU cyberdrills initiative for capacity building; • increasing the number of secure internet servers. Improvement of the resilience level of network/ISP within eighteen months by: • reaching a complete coverage of the country; • completing the deployment of 4G networks; • deploying renewable power systems on the rural BTS. Improvement of the resilience level of network/ISP in the long term by deploying broadband networks in rural areas.

Market resilience

The measurement of chokepoint potential is based on three parameters: the level of market concentration (ensuring that there is diversity in the market share of operators); the level of spectrum concentration (ensuring that no operator is too dominant in terms of spectrum allocation); and the level of coverage diversity (ensuring that users have a diversity of access options from multiple operators).

The measurement of market concentration and spectrum concentration are performed using the Herfindahl-Hirschman Index (HHI), which is a common measure of market concentration used to determine market competitiveness, it can be used to check the level of concentration in other domains. The equation used to calculate HHI is provided in Appendix B. A market with an HHI of less than 1 500 is considered a competitive marketplace, an HHI of 1 500 to 2 500 is moderately concentrated, and an HHI of 2 500 or greater is highly concentrated.

Market share for fixed broadband subscriptions and HHI

Table 31: Fixed – broadband subscriptions

Operator	Fixed broadband subscriptions	Market share (%)
Digicel	21 700	70
Natcom	9 330	30
Total	31 100	100
HHI	5 800	

source: ITU database

In Haiti, there is no dedicated fixed-network operator; fixed broadband services are provided by the two mobile operators: Digicel and Natcom. The market share for fixed service subscription is shown in Table 31. The HHI is 5 800 which shows there is high concentration in this sub-market in Haiti.

Market share for mobile operator and HHI

Table 32: Mobile – broadband subscriptions

Mobile operator	Mobile broadband subscriptions	Market share (%)
Digicel	2 011 621	62.26
Natcom	1 219 379	37.74
Total	3 231 000	100
HHI	5 413	

source: ITU database

The market share for mobile operators in Haiti is shown in table 32. The HHI is 5 413, which represents a high concentration in mobile service. The reason is because there are not many operators.

Frequency allocations

Table 33: Amount of spectrum allocated per operator

FREQUENCY BAND (MHz)	DIGICEL		NATCOM		ACCESS Haiti	
	QTY (MHz)	SUB-BAND (MHz)	QTY (MHz)	SUB-BAND (MHz)	QTY (MHz)	SUB-BAND (MHz)
610-960	20	824-844/ 869-889			10	809-819/ 854-864
	10	890-900/ 935-945	15	900-915/ 945-960		
1 710-2 200	39	1 720-1 759/ 1 815-1 854	10	1 710-1 720/ 2 110-2 120		
			25	1 760-1 785/ 1 855-1 880		
1 710-2 200	10	1 950-1 960/ 2 140–2 150	19	1 930-1 949/ 2 120-2 139		
2 300-2 400	90	2 300–2 390				
2 500-2 690			45	2 500-2 545	138	2 548-2 686
3 400-3 600					50	3 400-3 450/ 3 500-2 550
Total	**169**		**114**		**198**	

Source: CONATEL

It is noted that Access Haiti, the leading ISP, is allocated 198 MHz. Most of its spectrum comes from the sub-bands of 2 500–2 609 MHz, and 3 400-3 600 MHz.

Spectrum share for mobile operator and HHI

Table 34: Amount of spectrum allocated per operator

Operator	Spectrum share (MHz)	Spectrum share (%)
Digicel	169	59.71
Natcom	114	40.28
Total	283	100
HHI	5 200	

Source: CONATEL

The spectrum share for mobile operators is indicated in the Table 34. The calculated HHI is 5 200. In this case, there is a high concentration in spectrum allocation. This situation can be explained by the fact that there are only two mobile operators in the market. The third parameter which is mobile coverage diversity cannot be applied in this situation, because the mobile markets is only served by two mobile operators.

Affordability is an important element of market resilience, since it describes the purchasing power of the population in accessing the telecommunication services. The values should be calculated for broadband packages including 1.5 GB and 5 GB, using World Bank data related to Gross National Income per capita (GNI per capita), and world telecommunication/ICT indicators database (ITU). However, the most recent values provided by World Bank for those indicators date from 2012, therefore they cannot be used to reflect the current situation.

The indicators defined by ITU in the digital development dashboard[61] elaborated for Haiti in 2021, which are attached as Appendix C, are the most recent figures that can give a minimal picture of the reality.

Figures for the Haiti market

- Fixed broadband basket as a percentage of GNI per capita: 52.8 per cent.
- Mobile data and voice basket (high consumption) as a percentage of GNI per capita: 19.5 per cent.
- Mobile data and voice basket (low consumption) as a percentage of GNI per capita: 18.8 per cent.
- Mobile broadband basket as a percentage of GNI per capita: 18.5 per cent.
- Mobile cellular basket as a percentage of GNI per capita: 4.8 per cent. Although, there is some progress in the fixed broadband basket, the other price indicators: Mobile data and voice basket (high consumption), mobile data and voice basket (low consumption), mobile broadband basket and mobile cellular basket are far from the targets established to ensure affordability for all.

According to World Bank data, the poverty rate reached near 60 per cent of the Haiti population in 2020. Most of the people live with less than three dollars a day, it is obvious that affordability is challenging. Affordable services and devices are two important tools that can help fight urban–rural digital divide within a country.

[61] Digital Development Dashboard is available at: https://www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspx.

In terms of market resilience, the performance of Haiti is still low. Market and spectrum concentration are barriers to competition, which could in the future decelerate progress in the sector. The challenges to the affordability need to be addressed before Haiti's population can reach an acceptable level of access and usage of broadband services.

It is recommended that Haiti adapt its strategies in the light of the new targets set by the United Nations (UN) for universal meaningful connectivity for all by 2030. These targets are based on three pillars:

1. Universality: By 2030, Universality of Internet for all relies on three targets:

a) Use of Internet for everyone aged of 15 and older, access to all households, use of Internet by all businesses, connection for all schools, coverage of 100 per cent for all population by latest mobile networks, and ownership of a mobile phone for everyone aged of 15 or older.
b) Basic digital skills for 70 per cent of users, and intermediate digital skills for 50 per cent of users.
c) Digital gender parity.

2. Technology: By 2030, four targets are related to technology:

- Speed of 10 Mbit/s for all fixed-broadband subscriptions.
- Connection (download speed) of 20 Mbit/s for very school.
- Availability of 20 kbit/s per student.
- Minimum of 200 GB of data allowance.

3. Affordability: By 2030, two targets are related to affordability of broadband Internet:

- Entry-level broadband subscription to be less than 2 per cent of monthly gross national income per capita in accordance with the UN Broadband Commission affordability target.
- Cost not exceeding 2 per cent of the average income of the bottom 40 per cent of the population.[62]

Box 14: Recommendations: Resilience market

Key recommendations
Improvement of the resilience level within three months by launching awareness campaign for the protection of infrastructure deployed. Improvement of the resilience level within nine months by: • implementing strategies to reach a balance in the mobile market; • creating conditions for competition for the benefit of consumers and users. Improvement of the resilience level within eighteen months by: • prioritizing the deployment of broadband in rural areas; • implementing infrastructure sharing. Improvement of the resilience level in the long term by: • opening the market to new entrants; • allocating mobile frequency bands for 5G networks.

[62] New UN targets chart path to universal meaningful connectivity is available at: https://www.itu.int/hub/2022/04/new-un-targets-chart-path-to-universal-meaningful-connectivity/.

6 Measurement of connectivity

6.1 Connectivity measurement methodology

In order to assess the connectivity of affected regions, field trips were planned in order to measure the level of connectivity of the rural populations. The connectivity level was measured in different points in each commune. This measurement provided the level of availability and penetration of 2G, 3G and 4G services.

Table 35 was used to collect the data, using two cellular phones (Digicel and Natcom). In addition to the level of signal and type of service available, these field trips have helped to discover areas that are not served by one or two mobile operators, or by both. This measurement is primarily focused in rural areas, therefore, only mobile operators are targeted, since they have larger coverage over the territory to provide both voice and data services. The services of the ISPs are available only in the main cities, so, they were not taken into account in this measurement.

These data gave the regulator a real picture of the availability and the penetration rate of services in the whole territory. During these field trips, questions related to the quality of service perceived were randomly asked to users. They expressed their level of satisfaction or frustration in different ways. The majority of the complaints are related to data service. In the far remote areas, it was noticed that even 2G service was not available in some localities.

Connectivity measurement form

Table 35: Connectivity measurement

Locality/ Commune	Operator 1				Operator 2			
	Service	Signal level (dBm)	Data network	Comments	Service	Signal level (dBm)	Data network	Comments
	2G				2G			
	3G				3G			
	4G				4G			

Source: Author

6.2 Current issues related to rural connectivity

From the observations made during the field trips, the following issues have been detected.

1. Absence of one operator in several communes in the southern part

One operator has not served several communes for years. This situation has existed since Hurricane Matthew destroyed the BTS installed in those communes. The operator has decided to dismantle the infrastructure and did not replace them. Users interested in benefiting from competition are still expecting the return of the services of this operator.

2. Long downtime of operations in some communes

In several communes in the southern and northern parts, the service may be non–operational for more than a week. Absence of maintenance and technical failure might be among the causes. The users who are completely disconnected complained about the delay of technical teams to solve the problems.

3. Unavailability of service during the night in several communes

Several communes in rural areas are mostly served during the day hours. The service is switched off in the night. This choice might be driven by the fact that few people live in those areas, and they will probably not consume services during the night, and service is switched off to cover the operating costs.

4. Frequent non-operation of BTS powered by solar panels

In some communes where BTS are powered by solar energy, the service may not be available during the night because the level required can only be found during the day. The batteries of the site cannot guarantee service continuity during all night. This situation occurs frequently during the rainy season; and the system cannot be powered by solar energy. During these periods, users cannot access the service for several days.

5. Very weak signals for 2G, 3G and 4G networks

The measurements taken in most of the localities show very weak signal levels. Most of the localities are connected with signal levels lower than –90 dBm, which makes communication almost impossible. In some areas, the signals levels reach –132 dBm, which cannot be used for any service.

6.3 Threats to connectivity

In Haiti, connectivity in urban and rural areas remains a challenging issue. Populations living in rural areas are either unserved or underserved. A significant percentage of rural areas are still not covered by 3G or 4G signals. The 2G service is not always available for different causes. Besides lack of investment and incentive, the following factors are considered as the major threats to connectivity, including fibre cuts, vandalisms, community disturbance, access roads, fuel theft and natural disasters. Moreover, due to the weak purchasing power of people living in rural areas, the return on investment is not always guaranteed; and it becomes therefore a burden for operators to deploy and maintain infrastructure in those remote regions.

6.4 Meetings with the operators for follow up on connectivity issues

After the presentation of the results of connectivity measurement, CONATEL decided to hold separate meetings with the two mobile operators to address this crucial issue. This meeting had two main objectives:

1) Presentation of the current situation in rural areas.
2) Improve the quality of service provided in the whole territory.

During that meeting, the levels of connectivity measured were shown, and the operators requested the documents for internal follow up. Given the importance of that question, the

regulator and the operators agreed to meet again. In the next scheduled meeting, the mobile operators should present the strategies they will use to increase the coverage of rural areas, and through maintenance and regular fuelling of base stations, to guarantee service availability.

6.5 Quality of service

In a normal and conducive environment, the quality of telecommunication services depends exclusively on a number of technical regulatory requirements that operators have to meet. In the current situation, quality of services is limited by the following additional factors:

- Vandalism on telecommunication infrastructure: Cables cut during period of political turmoil and tension are a big issue. A cable cut can affect service availability in different geographic departments.
- Theft of fuel: The theft of fuel meant for the generator is a regular practice in some regions. Base stations cannot operate without fuel and deprives users of service.
- Violence on site locations: In some areas, access to transmission sites may be blocked. This situation prevents maintenance and refuelling of generators and leads to the loss of service.
- Community disturbance: Community disturbance may block access to base stations leading to loss of telecommunication services.
- Coverage of mobile operators: The two mobile operators do not cover the whole territory. They face different challenges, including the terrain, lack of access roads, and a lack of energy supplies. These constraints lead to areas not covered or only partially covered.
- 2G service: In many rural areas, only 2G service is available. In those regions, users cannot access the Internet.
- Radioelectric interferences: This is a recurrent problem that operators face daily. The main sources of radio interferences can come from both legal and illegal radio stations, which can lead to the interruption of calls, and severely affect quality of service.

Normally, in the aftermath of a natural disaster, network congestion should be expected because many users are rushing to use the network to try to connect with their loved ones. Where network and infrastructure are damaged or destroyed, the capacity of the network decreases, which increases congestion and leads operators to put call restrictions in place to protect the network and prioritize emergency calls. In the aftermath of the most recent earthquake, the impact on infrastructure in the affected areas was limited to cables, base stations, and generators. The core network was not affected, generating lower levels of network congestion.

Box 15: Recommendations: Connectivity

Key recommendations
Improvement of the quality of service within three months by: • increasing signal strength for better quality of service; • guaranteeing night-time service continuity in all communes. Improvement of quality of service within nine months by: • managing better energy supplies to base stations in rural areas; • resolving technical failures in a timely manner. Improvement of quality of service within 18 months by: • all operators providing services in all communes; • deploying 4G infrastructure in the main cities.

7 Emergency telecommunication

7.1 National emergency telecommunication plan and national risk and disaster management plan

The State of Emergency Law passed in 2008 recommended to establish a national risk and disaster management plan in Haiti. This plan was developed in 2019 and should be used until 2030. The plan is based on four axes. The axes target ten results and envisage 62 activities.[63]

A national emergency telecommunication plan (NETP), which includes the mobilization of telecommunication networks and infrastructure, is an integral part of any national disaster management plan to enable rescue and relief operations. All telecommunication services should be considered when drafting an emergency telecommunication plan. There is presently no NETP or national strategy for the use of telecommunication services in the context of disaster risk reduction and management, and no entity has been designated to develop an NETP.

7.2 NETP and disaster management phases

Telecommunication/ICT networks and infrastructure play essential roles in the management of operations before, during and after disasters. Different types of communications are necessary in these circumstances:

- communication between authorities and organizations for the management of the crisis;
- communication from users to authorities (emergency calls);
- communication from authorities and organizations to the population (warning messages); and
- communication among the population.

Real time communications can guarantee speed, quality and effectiveness of the emergency responses provided by the government and other organizations. In order to have those benefits, the availability and reliability of the networks must be guaranteed. It is also important to be able to deploy temporary capacity or services in areas that need to be prioritized in the wake of a disaster. The effectiveness of telecommunication/ICT services is measured by their capacity to help save lives and support livelihoods.

The NETP is a tool that is used in all phases of disaster management: risk assessment, preparedness, alert, response, recovery and post disaster.

Phase 1: Risk assessment

In the first phase, telecommunication/ICT tools can be used for the following tasks:

- hazard prediction and modelling;
- systemic, multi-risk approach;
- vulnerability management; and
- building resilient communities.[64]

[63] Plan national de gestion des risques de désastre 2019-2030.
[64] Global guidelines to develop national emergency telecommunications plans – ITU available at: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Documents/2020/NETP-guidelines.pdf.

Phase 2: Preparedness

In the context of preparedness, telecommunication/ICTs are very useful in the following tasks:

- scenarios development;
- emergency planning maps; and
- training.

Phase 3: Alert

In order to alert the populations affected, telecommunication/ICT are always mobilized for the tasks below:

- real time monitoring and forecasting;
- early warning;
- public warning; and
- scenario identification.

Phase 4: Response

In order to provide adequate responses after disasters, telecommunication/ICT tools are deployed to execute the activities below:

- emergency telecommunication;
- command control coordination;
- situational awareness, crisis maps;
- information communication;
- dispatching of resources; and
- victim identification and tracking.

Phase 5: Recovery

The recovery process is also facilitated by telecommunication/ICT in the following:

- early damage assessment; and
- re-establishing life-lines transport and communication infrastructure.

Phase 6: Post disaster

In the last phase of a disaster management, telecommunication/ICT are still needed for the following:

- lessons learnt;
- scenario update;
- socio-economic and environmental impact assessment; and
- vulnerability re-assessment.[65]

ITU-D and the Emergency Telecommunications Cluster (ETC) of the World Food Programme (WFP), ITU–D have elaborated an emergency telecommunication checklist that is intended to

[65] Global guidelines to develop national emergency telecommunication plans (ITU).

assess the level of preparedness of a given country. This checklist is a key component of any NETP.

7.3 Principles for the development of the NETP

Since the availability of an NETP is essential to the management of all phases of any kind of disaster, it is therefore important to emphasise the principles of its development.

The principles are based on four pillars:

- multi-hazard;
- multi-technology;
- multi-phase; and
- multistakeholder.

The principles for the development of a NETP are suggested by the ITU:

- adoption of a strategy addressing all potential hazards of the country;
- awareness campaign and stakeholder participation;
- training, drills and evaluation of telecommunication/ICT infrastructure covering all phases of disaster management;
- accurate assumptions about potential disasters during the implementation of the NETP;
- standard operating procedures for the identification of the types of communications/ technologies necessary for a given type of an emergency; and
- planning of the need for redundant communications networks.

The involvement of all stakeholders in the NETP is an essential step. This step should include awareness campaigns, commitment from relevant stakeholders, contributions and agreement on strategy, coordination and effective communications. For all phases of disaster management, individuals, teams, departments, and communities should be trained, and participate in drills in order to be better prepared. The decisions related to the implementation of the NETP should be based upon accurate information and situational awareness. In addition, standard operating procedures need to be identified for the types of communications necessary for a given type of emergency.[66] All states must use these guidelines to elaborate the NETP as part of a national plan on disaster management (NPDM).

7.4 Current status of emergency telecommunications

Emergency telecommunications are useful before, during and after a disaster. The use of ICTs in the management of past natural disasters in Haiti has underlined the importance to put in place a structure responsible for this.

In terms of legal framework, there are two provisions in the decree on telecommunications granting a monopoly on telecommunication services to the State.

1) The armed forces have priority for the use of the national system of telecommunications in the event of war or internal disturbances or in all cases of emergency.
2) Amateur radio licensees must make use of the equipment available to the telecommunications regulator, CONATEL, if required in urgent cases, such as interruption of telephone, radiotelephone or telegraph communications of State networks caused by

[66] Global guidelines to develop national emergency telecommunication plans (ITU).

bad weather or in any other circumstances deemed urgent when required by the Home Department.

Other than these two elements, there is no law or policy on the regulation of emergency telecommunications.

In Haiti, the Directorate of Civil Protection is the agency responsible within the government to manage situations caused by natural disasters. The Civil Protection has a VHF radio network that is usually mobilized to help coordinate operations on the ground. Besides that, the services of mobile operators and ISPs are used in affected areas, if the infrastructure is not damaged. Even if there is no NETP established yet in Haiti, telecommunication operators (MNOs, ISPs, broadcasters), civil protection services and other entities usually cooperate to provide response in emergency situations.

There are mechanisms for emergency telecommunications between various stakeholders from government entities including Ministry of ICT, telecom regulatory authority, meteorological services, disaster management agency, and customs. In order to better coordinate the emergency response, it is intended to use a single telephone number for all the emergency services. Currently, there is a particular number for fire, police, ambulance and civil protection services. This initiative will lead to a toll-free number that can be used nationwide.

It is always challenging for the MNOs and the ISPs to handle the traffic overload resulting from emergency situations. Several measures are proposed in chapter 5 regarding the deployment of additional resources to deal with the traffic increase.

7.5 Early warning system in Haiti

The EWS in place in Haiti for hurricanes is a nascent system of early warnings for tsunamis, and relatively advanced (but geographically limited) warning system for flooding.[67]

The World Food Programme, GSMA, CONATEL, Digicel and the Directorate of Civil Protection have discussed how to implement an early warning system in Haiti in order to alert and protect the population. Thanks to the common alerting protocol (CAP), the system should be a vital instrument that can be used by civil protection services to exchange urgent public warnings between alerting technologies. CAP is a standardized emergency messaging format that has been adopted and used worldwide. Its capacity to handle all-hazards alerting and warning over all kinds of media, increases warning efficiency and effectiveness.

It has been suggested that the system should be hosted within Digicel, and this project was approved for funding by an international financial organization. Details related to the launch of the platform, and the use by the civil protection have not yet been discussed. Two main applications of SAP mobile are used before, during and after disaster in Haiti: CB and SMS. Cell Broadcast Service (CBS) and Short Message Service (SMS) were among the most suitable technologies to deliver a mobile-driven Public Warning System. Cell Broadcast (CB) is not yet a common practice in Haiti to alert population at risk in a specific geographic location.

SMS (Short message Service) is another tool used to alert populations. Since SMS is compatible with all handsets and familiar to most mobile users, it is therefore expected that this tool will

[67] Haiti DDR Report available at: https://disasterlaw.ifrc.org/sites/default/files/media/disaster_law/2020-09/HAITI%20DRR%20Report.pdf.

reach more people. Civil protection services have already used SMS in the past to alert the population and plans to continue this system.

7.6 International cooperation in emergency telecommunications

Different international organizations intervene to provide emergency telecommunication services when disasters occur. Usually, after the occurrence of natural disasters in Haiti, ITU deploys teams on the ground and emergency communications equipment to help the government manage the situations. After the most recent earthquake, ITU sent satellite phones and Broadband Global Area Network (BGAN) terminals to the Haiti Government via CONATEL to help coordinate relief operations on the ground.

International and non-governmental organizations (NGOs) (ETC, GSMA, International Federation of Red Cross and Red Crescent Societies, WFP, Information Technology Disaster Resource Centre, Swedish Civil Contingencies Agency, Telecommunications Sans Frontières, World Vision International, Office for the Coordination of Humanitarian Affairs, GVF) were involved in the management of relief operations after the recent earthquake and needed telecommunication services for their operations. Those services were unavailable in some affected areas, and they had to deploy their own telecommunication equipment. They installed two VHF radio networks, and deployed several VSATs. The debriefing meetings often discussed issues encountered during transportation and custom clearance for the emergency communications equipment.

The World Bank has expressed its interest in providing assistance to set up an emergency telecommunication system. The project is ongoing, and it involves mainly the regulatory body of the sector.

7.7 Tampere Convention status in Haiti

The Tampere Convention is an instrument that allows the provision of prompt telecommunication assistance to mitigate the impact of a disaster, and covers both the installation and operation of reliable, flexible telecommunication services. This instrument was conceived to waive regulatory barriers that impede the use of telecommunication resources for disasters. The legal barriers include the licensing requirements to use allocated frequencies, restrictions on the import of telecommunication equipment, as well as limitations on the movement of humanitarian teams.[68]

This Convention describes the procedures related to the request, provision, control and coordination of assistance in terms of emergency telecommunications. In order to use that Convention in the context of disasters, ITU Member States were called to sign it as a first step. The second step is the ratification of that international instrument by national parliaments before it can be implemented. Haiti has already signed it; the next step is to get it ratified by the Haiti parliament. This international instrument will be submitted to the next legislature for ratification in order to allow Haiti to benefit from this important Convention when disasters occur.

7.8 Sectoral Committee on Emergency Telecommunications Project

The creation of the Comité sectoriel sur les telecommunications d'urgence (sectoral committee on emergency telecommunications (COSTU)) is the result of an ongoing commitment between

[68] Tampere Convention available at: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/TampereConvention.aspx.

the Ministry of Public Works, Transport and Communications (TPTC) through the National Telecommunications Council (CONATEL) and the Ministry of the Interior and Territorial Collectivities (MICT) through the Civil Protection Directorate (DPC).

The creation of the sector committee reflects the government desire to strengthen disaster prevention, preparedness and response measures through joint planning and to take advantage of the essential role that telecommunications must play in this regard.

7.9 Mission and terms of reference of COSTU

The sectoral committee has the following responsibilities:

1) Coordinate strategy, direction and supervision with regard to emergency telecommunication needs in normal times as well as in emergency and disaster situations.
2) Ensure the effective and well-coordinated deployment of telecommunications and ICTs in support of the entire disaster cycle (preparedness, response and recovery).
3) Improve the effectiveness of humanitarian assistance and empower communities by providing adequate access to information and telecommunication services in emergencies.

7.10 Composition of COSTU

COSTU is a multi-stakeholder team composed of representatives of public authorities, the private sector, civil society and international organizations. It is chaired by the Director-General of CONATEL assisted by the Director of Civil Protection as Vice-Chair. Its members also include representatives of the following institutions: MTPTC and the Police Nationale d'Haiti (National Police of Haiti) for the public authorities; Digicel, Natcom for the mobile telephone operators; Association nationale des médias d'Haiti (National association of Haiti medias), Association des medias independants d'Haiti (Association of independent media of Haiti) and the Sosyete Animasyon Kominikasyon sosyal (Society for Animation and social Communication) for broadcasters; the World Food Programme (WFP); the Haiti Red Cross, Radio Club d'Haïti and AGERCA for the NGOs; international organizations and civil society. The President, in consultation with the Members, may invite other institutions to join COSTU.

7.11 Initiatives to increase availability, adoption, and resilience

The Connect2Recover methodology lists initiatives implemented by countries to increase availability, adoption and resilience during emergency situations and disasters. These initiatives include emergency measures, affordability, availability, spectrum policy and content distribution[69]. The following tables will assess the level of implementation of each item within each initiative in Haiti.

[69] Connect2Recover: A methodology for identifying connectivity gaps and strengthening resilience in the new normal.

Table 36: Emergency measures

Emergency measures			
Item	Yes	No	Comments
Mobilization of national emergency telecommunication plans (including emergency alerts)	X		
Deploying resources to handle traffic increases	X		
Allocation of toll-free numbers for emergency services	X		

Table 37: Affordability

Affordability			
Item	Yes	No	Comments
Discounted services and devices for low-income consumers	X		The discount often applies to services, not the devices themselves
Commitment not to shut off service for unpaid bills	X		For a short period
Free connectivity at community centres	X		
Free outdoor public Wi-Fi hotspots	X		
Free 4G/Wi-Fi routers for students		X	
Zero-rated education and other content		X	
Reduced sale tax on broadband services		X	
Free device charging schemes	X		

Table 38: Availability

Availability			
Item	Yes	No	Comments
Acceleration of network deployments in rural areas		X	
Release of additional capacity on mobile, fixed wireless, and satellite networks	X		Satellites networks are not available in Haiti
Expedited deployment of fixed wireless networks		X	They only have cell site on wheels that can be deployed to replace a damaged or destroyed BTS
Extended connectivity for health care providers and schools		X	
Waiver of rights-of-way (leeway) fees	X		

Table 39: Spectrum policy

Spectrum policy			
Item	Yes	No	Comments
Rapid issuance of spectrum temporary authorizations	X		
Accelerated allocations and assignments	X		
Extension of spectrum licence terms	X		
Minimizing licensee regulatory and reporting obligations	X		

Table 40: Content distribution

Content distribution			
Item	Yes	No	Comments
Government information and advisories	X		The government always uses television and radio stations, and other electronic communication means to send alerts and educate the populations
Television and radio stations disseminating health, safety, and educational content	X		Television and radio stations are required to disseminate warning messages and healthy, safety and educational content
Creation of local news platforms		X	
Applications to disseminate health information.		X	

Table 40: Content distribution (continued)

Content distribution			
Item	Yes	No	Comments
Commitments from platform companies to limit spread of COVID-19 disinformation		X	

7.12 Emergency telecommunication preparedness checklist

The International Telecommunications Union and the Emergency Telecommunications Cluster (ETC), a structure of World Food Programme (WFP), have jointly developed a resource to enable emergency telecommunication preparedness for disaster management. This emergency telecommunication preparedness checklist examines readiness in four key thematic areas:

1) National government: roles, responsibilities and coordination provisions.
2) External coordination with key stakeholders.
3) Capacity development: trainings and simulation exercises.
4) Infrastructure and technology: requirements, planning and maintenance.[70]

Every country should assess their level of preparedness in the light of the questions related to the four key thematic areas. The level of readiness of Haiti will be assessed through these four thematic areas. For the first key thematic area, *national government: roles, responsibilities and coordination provisions,* there are 20 questions.

National government: roles, responsibilities and coordination provisions

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
1	Is there a designated government ministry/agency responsible for disaster management in the country?	1	Active
2	Does the lead disaster management ministry/ agency coordinate with other relevant ministries across government for disaster management?	1	Operational and efficient
3	Are there any ICT-specific legislations or mandates which enable the ICT ministry/agency and the national ICT regulator, to respond to certain aspects of preparedness and response?	0	
4	Is there a standard operating procedure in place, outlining the role and mandate of the ICT ministry/ agency and regulator, with regards to preparedness and response?	0	
5	Are there clearly defined points of contact established for disaster management in the respective agencies/ministries involved?	1	Active

[70] Emergency Telecommunications Preparedness Checklist available at https://www.etcluster.org/document/emergency-telecommunications-preparedness-checklist.

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
6	Can key contacts (identified in question 5) be reached at any time of the day or night?	1	
7	Is there a national emergency telecoms cluster group established, representing key ICT contact persons?	0	Not completed
8	Does the core ICT contact group meet yearly to coordinate and/or conduct drills/exercises?	0	
9	Are roles, goals, and responsibilities coordinated across national to sub-national and community levels?	0	
10	Are there mechanisms that help emergency response agencies and policymakers to plan and implement interoperability solutions for data and voice communications including governance, standard operating procedures (SOPs), technology, training and exercises, and usage of interoperable communications?	0	
11	Are there methods/tools that jurisdictions that can be used to track progress in strengthening interoperable communications across the country?	0	
12	Is telecommunication/ICT prioritized, or addressed, as a critical function or priority within the country's disaster management framework?	1	Usual
13	Does the communications ministry/agency or regulator coordinate with, and participate in, the activities of the national disaster management agency?	1	Usual
14	Has a national-level ICT Working Group been established?	0	
15	Does the national ICT Working Group meet regularly?		
16	Has an up-to-date national ICT capacity assessment been done, which covers macro and micro assessments of country-level ICT infrastructure?	0	
17	Is there an updated available list of telecommunications, information technology (IT), payment technology, and payment switch providers?	0	
18	Are relevant tools available for rapid beneficiary registration and assistance delivery?	1	
19	Is a roster of national IT service providers available and accessible?	0	

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
20	Have network operators identified their internal "surge capacity", to be able to recover post-disaster?	1	
	PERCENTAGE = 40%		

The second key thematic area: *External coordination with key stakeholders* deals with 11 questions related to the level of preparedness.

External coordination with key stakeholders

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
21	Is there a stakeholder engagement plan in place for disaster preparedness and response?	1	Active
22	Is there a regularly updated list of key points of contact for primary organizations working in disaster risk management (including government private sector, civil society, United Nations, and all key others)?	1	Usual
23	Is the list of key point of contact shared with these entities (mentioned in question 22)?	1	Active
24	Are these multiple stakeholders (mentioned in question 22) coordinated with frequently for preparedness and response readiness activities and actions?	1	Usual
25	Do key stakeholders have the ICT tools needed to communicate during non-disaster periods and emergency operations?	1	Sufficient
26	Are citizens involved in disaster risk reduction and response initiatives?	1	Low
27	Are citizens informed about disaster response preparedness and plans?	1	Low
28	Are there any requirements or legislations governing stakeholder engagement, public outreach, or advisory committees?	0	
29	Have processes been established in advance for both the entry of experts and communications equipment in times of disaster, such as the ratification of the Tampere Convention?	0	
30	Is there a fast-track process for importation of telecoms equipment in times of emergency?	0	

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
31	Are persons with disabilities, specific needs, and other vulnerable groups, included in disaster preparedness activities?	0	
	PERCENTAGE = 63.64%		

There are 16 questions related to the key thematic area: *Capacity development: trainings and simulation exercises.*

Capacity development: trainings and simulation exercises

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
32	Is ICT-specific training or certification mandatory for officials who are involved in disaster risk management?	0	
33	Do such trainings (mentioned in question 32) take place regularly?	0	
34	Do ICT-specific trainings and exercises include different concerned key stakeholders, in addition to government participants?	0	
35	Are telecommunication drills conducted to ensure that the public is aware of disaster response plans, including the most efficient means of communications to help reduce network congestion, together with recognition and reaction to a warning signal (e.g., response to an early warning mechanism like a siren)	0	
36	Has a personal communications plan for family check-ins and evacuations been prepared?	0	
37	Are communications/ICT exercises conducted, as part of more comprehensive national disaster exercises?	0	
38	Are communications/ICT exercises tailored to the types of frequently occurring disasters in the country?	0	
39	In communications/ICT exercises, are complex emergencies considered that could address multiple hazards in a "worst case scenario"?	0	
40	Do other government agencies or ministries oversee and/or participate in communications-related exercises or drills?	0	

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
41	Are different non-government stakeholder participants in disaster response or disaster communications exercises?	0	
42	Do all the ICT sector stakeholders participating in disaster exercises or drills have clearly defined roles and responsibilities?	0	
43	Are outage reporting requirements of carriers exercised?	1	Not frequent
44	Do carriers follow a uniform reporting process, and know which contacts to report the outages (induced by disaster) to, and how?	1	Normal
45	Is online ICT training, or are "read-aheads", available for ICT stakeholders prior to exercises?	0	
46	Is feedback collected after exercises or drills to help improve procedures or performance for the future?	0	
47	Is an "after action" performed after an exercise or drill?	0	
	PERCENTAGE = 12.5%		

The key thematic area 4: *Infrastructure and Technology: requirements, planning and maintenance* contains 34 questions that are used to assess the preparedness in terms of infrastructure and technology.

Infrastructure and technology: requirements, planning and maintenance

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
48	Is a regular technology inventory or assessment undertaken?	0	
49	Does such an inventory or assessment (as mentioned in question 48) have a mapping of infrastructure and networks available (publicly)	0	
50	Is redundancy and resiliency planning undertaken for telecom providers?	1	Usual
51	Are there opportunities to support or encourage telecommunication operators in doing the redundancy and resiliency planning? This could include advisory efforts, opportunities to engage in drills and exercises, and after actions, information-sharing efforts.	1	Frequent

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
52	Are processes in place for the government to help expedite, facilitate, prioritize, or enable fuel delivery for communications network generators?	1	Usual
53	Are there available and pre-positioned power sources for telecommunication networks?	1	Usual
54	Are there guidelines in place for critical facilities to have back-up power supplies?	0	
55	Are regular technical trainings conducted for those personnel who will need to use and maintain/test emergency communications equipment, particularly that which is pre-positioned?	0	
56	Do first responders know where the pre-positioned equipment is located or where imported ICT equipment can be collected for use?	1	
57	Are local communities and local staff also considered for training in the use and maintenance of emergency telecommunication equipment?	0	
58	Have critical /priority telecommunication sites being identified for restoration?	1	
59	Are there mechanisms in place to prioritize critical telecommunication sites for restoration efforts	0	
60	Are related reporting mechanisms in place?	0	
61	Has there been an assessment of ICT regulatory and/or policy barriers to entry or operation of needed equipment for disaster relief or restoration of networks?	0	
62	In the above-mentioned ICT assessment (question 61), have special measures been determined in case of an emergency, including identification of equipment for replacement, sources for rapidly sourcing equipment in times of need, determining redundant backup systems, and logistics capacity?	1	Usual
63	Is connectivity information, including data sets, available for government or public use to aid in disaster response and risk reduction planning	1	Usual
64	Is information about business continuity plans exchanged between government and industry officials?	1	Usual

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
65	Have emergency and network resilience/redundancy needs and requirements been considered in the national telecommunication development plan?	0	
66	Are policies in place to ensure that data can be shared by operators with responders in a way that protects individual privacy, while enabling response?	0	
67	Are multiple channels (such as television, Radio, Short Message Service, messaging, etc.) employed to ensure information gets to those affected quickly and effectively?	1	Regular
68	Is social media employed to share information regarding disaster risk reduction?	1	Frequent
69	Are regular/ongoing national and regional alerting exercises and system-testing taking place?	0	
70	Is public education undertaken to sensitize communities on early warning for early action?	1	Usual
71	Are members of vulnerable populations consulted regarding their specific needs in disaster scenarios?	0	
72	Is there an early warning alerting system in place?	1	New
73	Is the Common Alerting Protocol (CAP) employed for early warning purposes?	0	
74	Are information materials including websites or applications ("apps") accessible for disaster preparedness?	0	
75	Are the above-mentioned "apps" (in question 74) promoted widely to the public?	0	
76	Are information materials being shared in advance on ways that users of communications can lessen network congestion in a disaster?	0	
77	Are ICT capacities of vulnerable populations being developed in disaster risk management?	0	
78	Are accessibility and usability of ICTs considered in forthcoming disaster preparedness projects?	1	Usual
79	Are disaster readiness information materials provided targeting vulnerable populations?	0	
80	Are public awareness campaigns conducted on disaster risk reduction themes in multiple accessible formats in different prevalent languages?	1	Regular

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
81	Following a disaster, are disaster response efforts reviewed to assess challenges for vulnerable groups, and determine follow up actions?	1	Usual
	PERCENTAGE = 47.05 %		

The fourth thematic area includes three additional sections: ICT assessment and damage mitigation, emergency connectivity provisions and approach, and network maintenance and reestablishment.

A: ICT assessment and damage mitigation

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
82	Is there a designated focal point at the ministry/regulator to collect, analyze, and react to/ report/release information regarding damage to networks?	0	
83	Is a mechanism in place to enable communications operators to provide the government information about the scale and scope of communications outages, and their progress on restoration in a way that enables governments to plan and act?	0	
84	Is the reporting system separate or "firewalled" from regulatory functions to enable more open reporting on outages?	0	
85	For those networks that are commercial or public, are there reporting requirements in place that would establish a harmonized process, format, and timeline carriers to submit evaluations?	0	
86	Will initial damage assessments be connected to award disaster recovery funding?	0	
87	Have interagency coordination and information sharing processes been established?	1	Usual
88	Are there policies in place that consider communications network status, needs, conditions and requests, and that enable the maintenance and restoration of the following communications capabilities?	0	
89	Is standardized reporting on outages undertaken by the regulator at regular intervals, identifying the number of telecom sites that are up and/or down?	0	

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
90	Are telecoms recovery plans produced, to recover or continue the operation and use of telecoms infrastructure in the event of disaster?	0	
91	Do the above-mentioned telecoms recovery plans (in question 90) detail coverage areas and network carrying capacity – including provision of special services and network access for affected areas?	0	
92	As a business continuity management (BCM) measure post-disaster, are network recovery mitigation plans made available by network operators, and are accessible?	0	
	PERCENTAGE = 9.09%		

B: Emergency connectivity provisions and approach

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
93	Has the government identified relevant network operators and service providers, including domestic telecommunication providers and international satellite operators, who may be involved in providing emergency communications services?	0	
94	Is there a maintained list containing updated details for all relevant telecoms service provider recovery teams?	0	
95	Is there a system in place for offers of financial and human capacity assistance from foreign governments, humanitarian organizations, or private sector to be received and processed?	1	Regular
96	Is the ICT ministry or regulator the contact for authorization of incoming equipment (such as frequency and type approvals), or to allocate requested frequencies?	1	Usual
97	Has the government created frequency allocations, in conformance with the international table of allocations, for critical satellite communications frequency bands – including in the L, C, Ku, and Ka bands?	1	Active
98	Is there a mechanism to ensure timely coordination with local operators to avoid interference?	0	
99	Are emergency ICT resources prepositioned at priority locations?	0	

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
100	Does the government encourage or enable carriers to preposition emergency ICT resources?	1	Usual
101	Is there a process in place for regular tests of the pre-positioned equipment to ensure its functionality?	0	
102	Is consideration/priority given to fuel supplies for power generators and restoration of telecommunication networks?	1	Usual
103	Is coordination between national government-specific telecommunication teams and the central disaster management institutions undertaken?	1	Usual
104	Is there a prioritization exercise undertaken to determine where emergency connectivity will first be established?	0	
	PERCENTAGE = 50%		

C: Network maintenance and reestablishment

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
105	Is there a source of external expert advice and assistance for government agencies, with respect to restoring government communications networks and telecommunication infrastructure, including industry contacts?	0	
106	Does the government have mechanisms or emergency procedures in place to facilitate customs clearance or importation of equipment needed for restoration of critical networks, and/or to facilitate entry of any external expert personnel needed to restore and rebuild networks?	0	
107	In case of pre-positioned equipment, has a focal point (or points) been identified to ensure it is well-maintained, and the ICT equipment is ready-for-use in an emergency?	0	
108	Is there a process in place to routinely test networks designed for emergency communication?	0	
109	Are commercial or public network operators encouraged to have a business continuity plan (BCP) in place?	1	Usual

(continued)

No	Question	Response (Yes/No Y=1, N=0)	Comments (Qualifying)
110	Are telecommunication restoration plans frequently exercised and updated?	0	
111	Does the ICT ministry/agency or regulator have information related to network outages and restoration activity safeguarded, and classified appropriately, to mitigate security concerns?	1	Usual
112	Does the ICT ministry/agency or regulator have a focal point for sharing communications outages and restoration information with other stakeholders?	0	
113	Has a forum for operators to share information and coordinate possible assistance been established by the ICT ministry/agency and/or regulator?	0	
114	Has a procedure been put in place to allow the government to share sensitive risk - related information with network operators (and vice versa)?	0	
115	Is there a procedure in place to assist operators with critical items, such as physical access and expedited fuel deliveries?	1	Active
116	Are there alternate sources of power located and prepared in case of emergency scenarios?	1	Usual
	PERCENTAGE = 33,34 %		

Box 16: Recommendations: Emergency telecommunication

Key recommendations
Improvement of emergency telecommunications within three months by: • reinforcing cooperation with ITU, ETC, OCHA, and others; • finalizing the set-up of the COSTU; • operationalizing all toll-free numbers dedicated to emergency telecommunications. Improvement of emergency telecommunications within nine months by: • deploying the early warning system; • signing bilateral agreements for all types of assistance; • cooperating with the United Nations Office for Disaster Risk Reduction; • ratifying the Tampere Convention; • coordinating with MNOs for traffic handling during emergency situations. Set -up of the NETP within eighteen months by using the principles and recommendations established by ITU.

8 Conclusion

This study has analysed the telecommunication ecosystem of Haiti. An emphasis was put on the assessment of existing recovery plan and level of resilience of telecommunication networks and infrastructure to natural disasters. The broadcasting sector was also assessed as a whole, as it is a mass media communication that is often mobilized in different phases of the response to natural disasters. Particular attention was paid to rural connectivity, as this aspect is critical in the effort to provide access to everyone.

At a time when the absence of telecommunication services can be equated to a complete black-out, the risk of seeing the telecommunication networks affected so that they cannot serve the end users is unimaginable. This assessment is a useful tool for services providers, the regulator and decision-makers. The data collected highlights the situation on the ground, including:

- the recovery plans of the mobile operators and ISPs are incomplete;
- mobile operators and the leading ISP are partially resilient;
- less than 10 per cent of radio and TV stations have means to recover after a disaster;
- the level of resilience of radio and TV stations is very low;
- rural connectivity is low, and faces multiple challenges; and
- emergency telecommunication preparedness and response needs to be strengthened.

Based on the data and the analysis, the regulator and operators must take measures to strengthen resiliency of digital network infrastructure for better preparedness in emergency telecommunications.

References

1 Requirements for Network Resilience and Recovery, ITU-T focus group on disaster relief systems, network resilience and recovery, May 2014, https://www.itu.int/en/ITU-T/focusgroups/drnrr/Pages/default.aspx

2 Round Table on the Reconstruction of Haiti, ITU, 29-30 June, 2010, Hilton Hotel, Barbados

3 Connect2Recover: A methodology for identifying connectivity gaps and strengthening resilience in the new normal, September 2021, https://www.itu.int/hub/publication/d-tnd-04-2021/

4 Telecommunications Resilience, National infrastructure Security Co – Ordination Centre, Good Practice Guide, 10 May 2004, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/85910/flu_niscc.pdf

5 Security of UK Telecommunications, The Parliamentary Office of Science and Technology, Westminster, London SW1A 0AA, https://researchbriefings.files.parliament.uk/documents/POST-PN-0584/POST-PN-0584.pdf

6 Public Safety Communications Network Resiliency Self-Assessment Guidebook, safecom, CISA, November 2018, https://www.cisa.gov/safecom/blog/2018/12/11/public-safety-communications-network-resiliency-self-assessment-guidebook

7 Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications Anthony M. Townsend and Mitchell L. Moss, https://reliefweb.int/sites/reliefweb.int/files/resources/nyu-disastercommunications1-final.pdf

Appendix A : Data sources

Table 41: Description of resilience data indicators, year obtained and data source

Pillar	Dimension	Indicator	Description	Year obtained (Haiti)	Data source
Critical infrastructure	Power infrastructure resilience	Power availability	Power availability for entire population	2020	World bank
	Cable infrastructure resilience	10-km Fibre reach (percent)	% of the population within 10 km of a fibre-optic network	2020	ITU
		Exit points (Gateways)	Number of international gateways	2021	MNOs and ISPS
	Mobile	Network coverage	Network coverage MCI composite indicator (3G,4G,5G)	2021	ITU
		Spectrum allocation	Spectrum allocation MCI composite indicator	2022	GSMA
	Number of IXPs	Number of IXPs	Total IXPs in the country	2021	AHTIC
		Number of IXPs per 10 million	IXPs per 10 million people	2022	Calculated
	Top Level domains	Number of ccTLDs	Number of Country Code Top Level Domains registered	2022	Zonefiles.io
		Number of people per ccTLD	Number of people per Country Code Top Level Domain	2022	Calculated
		% of apps in local language	Percentage of mobile apps in main local language	2019	GSMA

Table 41: Description of resilience data indicators, year obtained and data source (continued)

Pillar	Dimension	Indicator	Description	Year obtained (Haiti)	Data source
Network/ISP Resilience	Link resilience	Peering efficiency (percent ISP peering)	% of ISPs peering at local IXPs	2022	AHTIC
		Peering efficiency (percent IPs peering	% of IPs peering at local IXPs	2022	AHTIC
	Quality of service	**Fixed networks**		2022	Ookla
		Fixed Latency (ms)	Latency measured to the nearest speed test server	2022	Ookla
		Fixed Upload (Mbit/s)	Upload throughput measured to the nearest server	2022	Ookla
		Fixed Download (Mbit/s)	Download throughput measured to the nearest server	2022	Ookla
		Mobile networks		2022	Ookla
		Mobile Latency (ms)	Latency measured to the nearest speed test server	2022	Ookla
		Mobile Upload (Mbit/s)	Upload throughput measured to the nearest server	2022	Ookla
		Mobile Download (Mbit/s)	Download throughput measured to the nearest server	2022	Ookla
	Domain name server resilience	% of DNSSEC validation by country	% of DNSSEC validation by country	2021	APNIC
		DNSSEC adoption for TLDs	NSSEC adoption for TLDs	2021	ISOC Pulse2021

Table 41: Description of resilience data indicators, year obtained and data source (continued)

Pillar	Dimension	Indicator	Description	Year obtained (Haiti)	Data source
Network/ISP Resilience	Cybersecurity	Secure Internet Servers	Secure Internet Servers per 1 million people	2020	World Bank
		Global Cybersecurity Index	Global Cybersecurity Index	2020	ITU
		DDOS Full	Country overview of DDOS Potential in Tbit/sec	2021	Cybergreen
		Spam infections	% of IP addresses in the spam list	2021	Spamhauss
Market resilience	Chokepoint potential	Market concentration mobile operators	HHI Index for mobile market	2022	Conatel/ Operators (calculated)
		Market concentration fixed-network operators	HHI Index for fixed market	2022	Conatel/ Operators (calculated)
		Spectrum concentration	HHI Index for spectrum allocation	2022	Conatel/ Operators (calculated)
	Affordability	Fixed broadband basket as a % of GNI p.c	How affordable is fixed broadband for the country	2021	ITU
		Mobile data and voice basket (high consumption) as a % of GNI p.c	How affordable is mobile data and voice basket for high consumption	2021	ITU
		Mobile data and voice basket (low consumption) as a % of GNI p.c	How affordable is mobile data and voice basket for low consumption	2021	ITU
		Mobile broadband basket as a % of GNI per capita	How affordable is mobile broadband for the whole country	2021	ITU
		Mobile cellular basket as a % of GNI p.c	How affordable is mobile cellular basket for the whole country	2021	ITU

Table 42: Location of public data used in report

Description	Data source
% of allocation listed in the spam list	https://www.abuseat.org/public/countryinfections.html
% of ASN peering at local IXPs	https://www.pch.net/ixp/data
% of DNSSEC validation by country	https://stats.labs.apnic.net/dnssec
% of HTTPS usage	https://pulse.internetsociety.org
% of IPv6 adoption	https://pulse.internetsociety.org
% of the population within 10km of a fibre-optic network	https://www.itu.int/en/ITU-D/Technology/SiteAssets/Pages/InteractiveTransmissionMaps/ITU%20Broadband%20Capacity%20Indicators%202020.xlsx
International bandwidth, in Mbit/s	https://www.itu.int/itu-d/reports/statistics/2021/11/15/international-bandwidth-usage/
IXPs per 10 million	https://www.pch.net/ixp/data
Access to electricity (% of population)	https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS
Latency measured to the nearest speed test server	https://registry.opendata.aws/speedtest-global-performance/
Age and sex distribution of rural population (marz level)	https://armstat.am/file/doc/99524723.xlsx
Mobile-cellular subscriptions	https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
Core indicators on access to and use of ICT by households and individuals	https://www.itu.int/en/ITU-D/Statistics/Pages/coreindicators/default.aspx
Country overview of DDOS Potential	https://stats.cybergreen.net/country
DDoS risk a country poses to other countries	https://stats.cybergreen.net/download/
Download throughput measured to the nearest server	https://registry.opendata.aws/speedtest-global performance/
DNSSEC adoption for Top Level Domains	https://pulse.Internetsociety.org
Fixed-broadband subscriptions	www.itu.int/en/ITU-D/Statistics/Documents/statistics/2021/July/FixedBroadba ndSubscriptions_2000-2020.xlsx
Global Cybersecurity Index	https://www.itu.int/epublications/publication/globalcybersecurity-index-2020/en/
GSMA mobile coverage map	https://www.gsma.com/coverage/
ITU Interactive Transmission Network Maps	https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx

Table 42: Location of public data used in report (continued)

Description	Data source
Network coverage composite indicator	https://www.mobileconnectivityindex.com/widgets/conn ectivityIndex/excel/MCI_Data_2020.xlsx
Number of domain registered by ccTLD per person	https://zonefiles.io/cctld-domains/
Number of international gateways	https://docs.google.com/spreadsheets/d/1D4dIDW12_VzMI5vHQK2p48mmiOUvH0laLgnSXsUvbNw/edit#gid=0
Ookla country summary	https://www.speedtest.net/global-index
Ookla interactive map	https://www.ookla.com/ookla-for-good/open-data
Quality of power supply	https://www.doingbusiness.org/en/data/exploretopics/getting-electricity
Spam infections	https://www.abuseat.org/public/countryinfections.html
Upload throughput measured to the nearest server	https://registry.opendata.aws/speedtest-global-performance

Appendix B: Formula for chokepoint potential

Market concentration

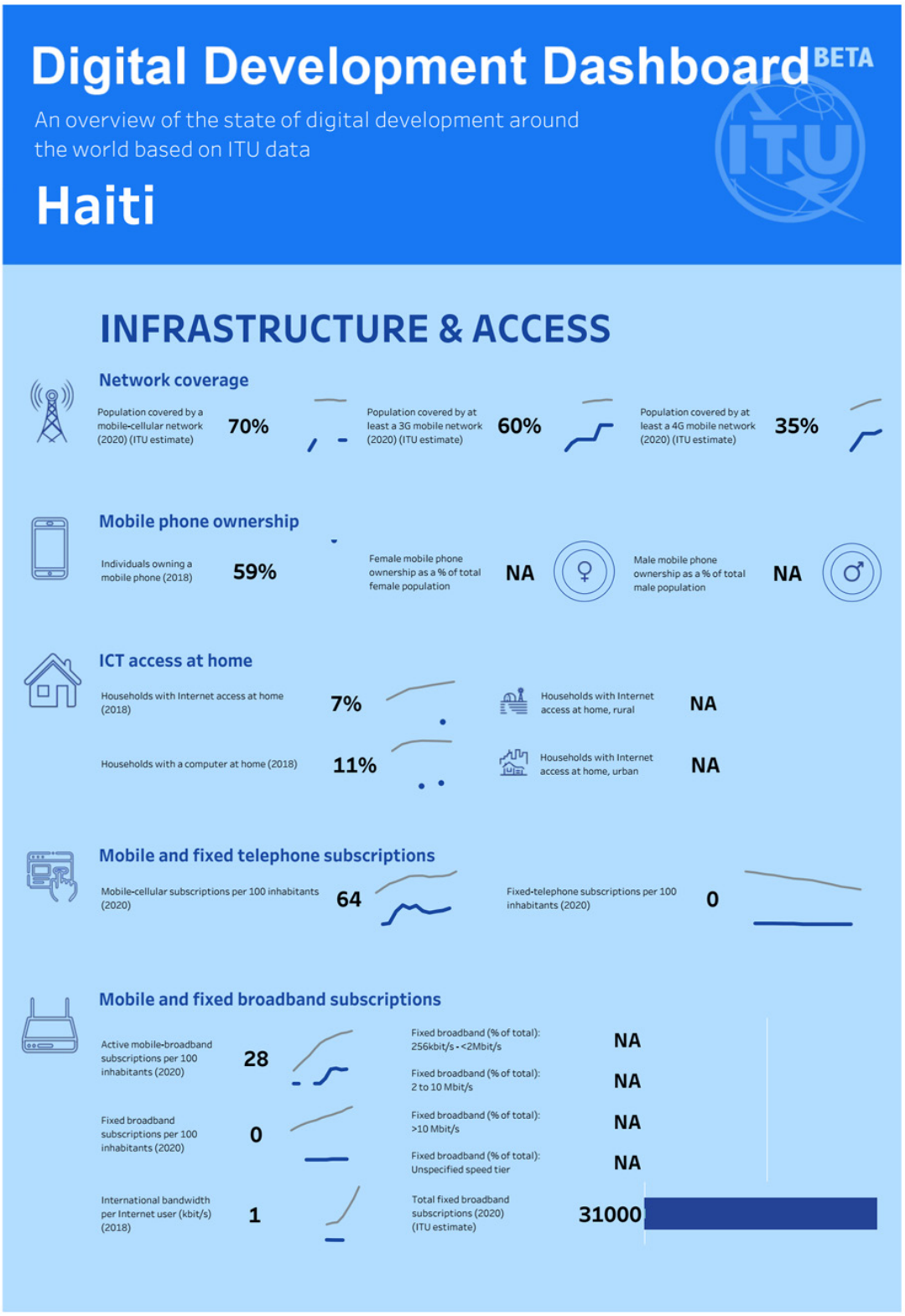
Market concentration and spectrum concentration are measured using the Herfindahl-Hirschman Index (HHI).

$$HHI = s1^2 + s2^2 + s3^2 + \cdots + sn^2$$

where: sn = the market share percentage of the entity expressed as a whole number, not a decimal

A market with an HHI of less than 1 500 is considered a competitive marketplace, an HHI of 1 500 to 2 500 is moderately concentrated, and an HHI of 2 500 or greater is highly concentrated.

Appendix C: Haiti Digital Development Dashboard



Haiti

INTERNET USE

Percentage of population using the Internet

Individuals using the Internet, total (2020) (ITU estimate)	34%
Female Internet use as a % of total female population	NA
Male Internet use as a % of total male population	NA
25-74 years as a % of all 25-74 years	NA
15-24 years as a % of all 15-24 years	NA
< 15 years as a % of all < 15 years	NA
75+ years as a % of all 75+ years	NA

Broadband traffic

Average monthly fixed broadband Internet traffic per fixed broadband subscription (MB)	NA
Average monthly mobile broadband Internet traffic per mobile broadband subscription (MB)	NA

ENABLERS & BARRIERS

ICT prices

Fixed broadband basket as a % of GNI p.c. (2021)	52.8%
Mobile data and voice basket (high consumption) as a % of GNI p.c. (2021)	19.5%
Mobile data and voice basket (low consumption) as a % of GNI p.c. (2021)	18.8%
Mobile broadband basket as a % of GNI p.c. (2021)	18.5%
Mobile cellular basket as a % of GNI p.c. (2021)	4.8%

ICT skills

Individuals with basic skills	NA
Individuals with standard skills	NA
Individuals with advanced skills	NA

About this dashboard

The Digital Development Dashboard reports the latest values for selected indicators drawn from three ITU data sets:

- **Telecommunication/ICT infrastructure and access data,** collected annually through one short and one long questionnaire. These indicators are defined in the ITU Handbook for the Collection of Administrative Data on Telecommunications/ICT.
- **Price data,** collected through an annual questionnaire. Price indicators are also defined in the ITU Handbook for the Collection of Administrative Data on Telecommunications/ICT.
- **Data on access to and use of ICTs by households and individuals,** collected annually through one short and one long questionnaire. These indicators are defined in the Manual for Measuring ICT Access and Use by Households and Individuals.

This version of the Dashboard uses data collected up to November 2021. When a value is not available, NA is reported. In some cases, it is possible that the value reported for disaggregated indicators is for a different period than the main indicator. For most indicators, values are rounded to the nearest integer. As a result, it is possible that the sum of the values of disaggregated indicators does not add up to 100%.

ICT skills

- **Basic skills:** the highest value among the following four computer-based activities: copying or moving a file or folder; using copy and paste tools to duplicate or move information within a document; sending e-mails with attached files; and transferring files between a computer and other devices.
- **Standard skills:** the highest value among the following four computer-based activities: using basic arithmetic formula in a spreadsheet; connecting and installing new devices; creating electronic presentations with presentation software; and finding, downloading, installing and configuring software.
- **Advanced skills:** the value for writing a computer programme using a specialized programming language.

Questions and comments: indicators@itu.int.

twitter.com/ITUDevelopment facebook.com/itu https://itu.int/itudata

Office of the Director
International Telecommunication Union (ITU)
Telecommunication Development Bureau (BDT)
Place des Nations
CH-1211 Geneva 20
Switzerland

Email: bdtdirector@itu.int
Tel.: +41 22 730 5035/5435
Fax: +41 22 730 5484

Office of Deputy Director and Regional Presence
Field Operations Coordination Department (DDR)
Place des Nations
CH-1211 Geneva 20
Switzerland

Email: bdtdeputydir@itu.int
Tel.: +41 22 730 5131
Fax: +41 22 730 5484

Digital Networks and Society (DNS)
Email: bdt-dns@itu.int
Tel.: +41 22 730 5421
Fax: +41 22 730 5484

Digital Knowledge Hub Department (DKH)
Email: bdt-dkh@itu.int
Tel.: +41 22 730 5900
Fax: +41 22 730 5484

Partnerships for Digital Development Department (PDD)
Email: bdt-pdd@itu.int
Tel.: +41 22 730 5447
Fax: +41 22 730 5484

Africa

Ethiopia
International Telecommunication Union (ITU) Regional Office
Gambia Road
Leghar Ethio Telecom Bldg. 3rd floor
P.O. Box 60 005
Addis Ababa
Ethiopia

Email: itu-ro-africa@itu.int
Tel.: +251 11 551 4977
Tel.: +251 11 551 4855
Tel.: +251 11 551 8328
Fax: +251 11 551 7299

Cameroon
Union internationale des télécommunications (UIT)
Bureau de zone
Immeuble CAMPOST, 3e étage
Boulevard du 20 mai
Boîte postale 11017
Yaoundé
Cameroon

Email: itu-yaounde@itu.int
Tel.: + 237 22 22 9292
Tel.: + 237 22 22 9291
Fax: + 237 22 22 9297

Senegal
Union internationale des télécommunications (UIT)
Bureau de zone
8, Route du Méridien Président
Immeuble Rokhaya, 3e étage
Boîte postale 29471
Dakar - Yoff
Senegal

Email: itu-dakar@itu.int
Tel.: +221 33 859 7010
Tel.: +221 33 859 7021
Fax: +221 33 868 6386

Zimbabwe
International Telecommunication Union (ITU) Area Office
USAF POTRAZ Building
877 Endeavour Crescent
Mount Pleasant Business Park
Harare
Zimbabwe

Email: itu-harare@itu.int
Tel.: +263 242 369015
Tel.: +263 242 369016

Americas

Brazil
União Internacional de Telecomunicações (UIT)
Escritório Regional
SAUS Quadra 6 Ed. Luis Eduardo Magalhães,
Bloco "E", 10º andar, Ala Sul (Anatel)
CEP 70070-940 Brasilia - DF
Brazil

Email: itubrasilia@itu.int
Tel.: +55 61 2312 2730-1
Tel.: +55 61 2312 2733-5
Fax: +55 61 2312 2738

Barbados
International Telecommunication Union (ITU) Area Office
United Nations House
Marine Gardens
Hastings, Christ Church
P.O. Box 1047
Bridgetown
Barbados

Email: itubridgetown@itu.int
Tel.: +1 246 431 0343
Fax: +1 246 437 7403

Chile
Unión Internacional de Telecomunicaciones (UIT)
Oficina de Representación de Área
Merced 753, Piso 4
Santiago de Chile
Chile

Email: itusantiago@itu.int
Tel.: +56 2 632 6134/6147
Fax: +56 2 632 6154

Honduras
Unión Internacional de Telecomunicaciones (UIT)
Oficina de Representación de Área
Colonia Altos de Miramontes
Calle principal, Edificio No. 1583
Frente a Santos y Cía
Apartado Postal 976
Tegucigalpa
Honduras

Email: ituteguciglapa@itu.int
Tel.: +504 2235 5470
Fax: +504 2235 5471

Arab States

Egypt
International Telecommunication Union (ITU) Regional Office
Smart Village, Building B 147,
3rd floor
Km 28 Cairo
Alexandria Desert Road
Giza Governorate
Cairo
Egypt

Email: itu-ro-arabstates@itu.int
Tel.: +202 3537 1777
Fax: +202 3537 1888

Asia-Pacific

Thailand
International Telecommunication Union (ITU) Regional Office
4th floor NBTC Region 1 Building
101 Chaengwattana Road
Laksi,
Bangkok 10210,
Thailand

Mailing address:
P.O. Box 178, Laksi Post Office
Laksi, Bangkok 10210, Thailand

Email: itu-ro-asiapacific@itu.int
Tel.: +66 2 574 9326 – 8
+66 2 575 0055

Indonesia
International Telecommunication Union (ITU) Area Office
Sapta Pesona Building
13th floor
Jl. Merdan Merdeka Barat No. 17
Jakarta 10110
Indonesia

Email: itu-ro-asiapacific@itu.int
Tel.: +62 21 381 3572
Tel.: +62 21 380 2322/2324
Fax: +62 21 389 5521

India
International Telecommunication Union (ITU) Area Office and Innovation Centre
C-DOT Campus
Mandi Road
Chhatarpur, Mehrauli
New Delhi 110030
India

Email: itu-ro-southasia@itu.int

CIS

Russian Federation
International Telecommunication Union (ITU) Regional Office
4, Building 1
Sergiy Radonezhsky Str.
Moscow 105120
Russian Federation
Email: itumoscow@itu.int
Tel.: +7 495 926 6070

Europe

Switzerland
International Telecommunication Union (ITU) Office for Europe
Place des Nations
CH-1211 Geneva 20
Switzerland

Email: eurregion@itu.int
Tel.: +41 22 730 5467
Fax: +41 22 730 5484

International Telecommunication Union
Telecommunication Development Bureau
Place des Nations
CH-1211 Geneva 20
Switzerland

ISBN: 978-92-61-38011-3

Published in
Switzerland Geneva,
2024

Photo credits: Adobe Stock