

ITU-D第3/1号课题输出成果报告

利用电信/ICT减少和管理灾害风险

2022-2025年研究期



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利用电信/ICT减少和管理灾害风险：ITU-D第3/1号课题2022-2025年研究期的输出成果报告。

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鸣谢

国际电联电信发展部门（ITU-D）研究组提供了一个中立性平台，来自世界各地的政府、业界、电信组织和学术界的专家可在此汇聚一堂，开发解决发展问题的实用工具和资源。为此，ITU-D的两个研究组负责在成员所提出输入意见的基础上编写报告、导则和建议。研究课题每四年由世界电信发展大会（WTDC）确定。国际电联成员于2022年6月在基加利举行的WTDC-22上商定，在2022-2025年期间，第1研究组将在“为有意义的连接创造有利环境”的总体范围内处理七项课题。

本报告是针对“第3/1号课题：利用电信/ICT减少和管理灾害风险”编写的，由ITU-D第1研究组的管理班子进行全面指导和协调。该研究组由主席Regina Fleur Assoumou-Bessou女士（科特迪瓦共和国）领导，并得到以下副主席的支持：Ali Rasheed Hamad Al-Hamad先生（科威特国）、Amah Vinyo Capo先生（多哥共和国）、George Anthony Giannoumis先生（挪威）、Roberto Mitsuke Hirayama先生（巴西联邦共和国）、Sangwon Ko先生（大韩民国）、Umida Musaeva女士（乌兹别克斯坦共和国）、Caecilia Nyamutswa女士（津巴布韦共和国）、Memiko Otsuki女士（日本）、Khayala Pashazade女士（阿塞拜疆共和国）、Sunil Singhal先生（印度共和国）、Mehmet Alper Tekin先生（土耳其共和国）。

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目录

鸣谢	iii
内容提要.....	ix
缩写词和首字母缩略语	x
第1章 – 引言	1
1.1 背景	1
1.2 报告范围	1
1.3 国际电联决议和国际电联其他部门的可交付成果	2
1.4 ICT与灾害管理和救灾	2
1.5 ICT在灾害管理与智慧可持续发展中的应用	3
1.6 有利的政策和监管环境.....	3
1.7 人为因素和利益攸关方协作.....	3
第2章 – 早期预警和警报系统.....	5
2.1 ICT在规划早期预警系统中的应用.....	5
2.2 部署降低灾害风险的早期预警系统.....	8
2.3 广播紧急预警系统.....	8
2.4 早期预警与警报系统技术.....	9
2.5 早期预警和遥感系统.....	10
2.6 灾害信息和救灾系统.....	10
第3章 – 复原力和压力测试的演习和演练	15
3.1 应急通信知识和培训在线模块.....	15
3.2 演习和模拟演练技术.....	16
3.3 复原力讲习班	16
3.4 在灾害所有阶段提高ICT复原力方面吸取的经验教训	16
第4章 – 有利的政策和监管环境	17
4.1 应急通信系统部署政策.....	18

4.2 促进早期预警、通信连续性和作出有效响应的政策	21
第5章 – 救灾通信技术	24
5.1 ICT促进灾害管理和智慧可持续发展	24
5.2 具有复原力的通信基础设施	28
5.3 人为因素和利益攸关方的协作	29
5.4 与灾害管理相关的其它报告	29
第6章 – 国家和行业案例研究	31
第7章 – 良好做法、导则和结论	36
7.1 分析并确定最佳做法导则和吸取的经验教训	36
7.2 ICT用于救灾、响应和恢复	36
7.3 其他无障碍获取方面的考虑	37
7.4 结论	37
Annexes	39
Annex 1 – Case studies	39
A1.1 Early warning and alerting systems	39
A1.2 Drills and exercises for resilience and stress tests	70
A1.3 Enabling policy and regulatory environment	85
A1.4 Disaster communication technologies	122
A1.5 Network resilience	141
A1.6 Human factors and stakeholder collaboration	147
A1.7 Other cases of disaster preparation, response, and recovery	155
Annex 2 – Related work of other sectors	174
A2.1 Collaboration with other Questions in ITU-D Study Groups 1 and 2	174
A2.2 Mapping of ITU-T and ITU-D Questions	174
A2.3 Mapping of ITU-R Working Parties and ITU-D Questions	174
Annex 3 – Information from ITU-T, ITU-R and other organizations	175
A3.1 AI for natural disaster management (ITU-T Study Group 2)	175

A3.2 Informative update in the area of disaster communications (ITU-R Disaster Relief Liaison Rapporteur).....	176
A3.3 Terrestrial broadcasting delivery for disaster relief (ITU-R Working Party 6A)	177
A3.4 Early warning systems using radiocommunication systems (APT ASTAP)	177
A3.5 Characteristics of fibre-optic submarine cable systems (ITU-T Study Group 15)	178
A3.6 Rapid response to sudden natural disasters in network (ITU-T Study Group 11) ..	179
A3.7 Emergency telecommunication specifications (ETSI TC EMTEL).....	179
A3.8 Emergency services (ITU-T Study Group 16 and ITU-T Study Group 21)	181
A3.9 International mobile telecommunications (IMT) for broadband public protection and disaster relief (PPDR)(ITU-R Working Party 5D)	181
A3.10 Development in the HAPS industry and regulatory recommendations to enable the stratospheric ecosystem (HAPS Alliance)	182
A3.11 Disaster response by Internet of Things (IoT) and disaster prevention for smart sustainable cities and communities (SSC&C) (ITU-T Study Group 20) ...	183
A3.12 Implementation of NEPT in Comoros (ITU-T Study Group 2)	184
Annex 4 – Information on workshops and panel sessions	185
A4.1 Emergency preparedness for disaster management	185
A4.2 Disaster management and resilience workshop	186
A4.3 Transformative connectivity: Satellite workshop	193
Annex 5 – Bibliography	197

表和图目录

表

表1: 案例研究.....	31
Table A-1: Summary of Disaster Preparedness Trainings Offered on DLG before the Earthquake	74
Table A-2: Summary of psychosocial support trainings offered on DLG after the earthquake	75
Table A-3: Summary of the 'Earthquake awareness' training programme	76
Table A-4: Statistics of 112 calls.....	113

Table A-5: Distribution of 112 calls.....	113
Table A-6: Recovery equipment in use (as of January 15, 2024).....	149
Table A-7: Key Indicators for electronic communications sector, by Province (2022)	156
Table A-8: Matrix of ITU-D Study Group 1 and 2 intra-sector coordination	174
Table A-9: Working Groups in FG-AI4NDM.....	175
Table A-10: The specifications and report of TC EMTEL	179
Table A-11: Newly developing work items related to disaster management in ITU-T SG16.....	181
Table A-12: SG20 work items on disaster risk reduction and management.....	183

图

图1: 联合国全民早期预警举措的四大支柱	6
图2: 移动网络和服务的发展为早期预警带来新机遇	7
图3: 采用AI实现地理信息可视化的GIS工作流程	13
图4: 2022年巴基斯坦洪灾地图.....	13
图5: 配有定向天线的频谱分析仪.....	24
图6: 中型垂直起降固定翼无人机图像.....	25
图7: 使用垂直起降的HAPS图像	25
图8: 系统比较.....	26
Figure A-1: EWBS-CAP hybrid transmission.....	48
Figure A-2: Accessible disaster alerting system with avatar sign language	49
Figure A-3: Accessible disaster alerting system diagram.....	50
Figure A-4: The CAM interconnection in 2019	53
Figure A-5: Hypothetical locations of desired sensors in the CAM region. Source: IPMA.....	54
Figure A-6: Visual IoT concept.....	57
Figure A-7: Overlay of visual IoT image on 3D WebGIS.....	58
Figure A-8: Visual IoT system.....	58
Figure A-9: Smoke detection via real-time image processing [Kikuta et al.]	59
Figure A-10: Heavy losses and the difficulty of prevention, represent huge challenges for the safe operation of oil and gas pipelines	61
Figure A-11: Rayleigh-scatter, Brillouin-scatter, and Raman-scatter.....	62
Figure A-12: Fibre-optic sensing risk awareness and warning solution.....	63
Figure A-13: System overview of L-Alert system	65
Figure A-14: Image of SMS blast (1)	77
Figure A-15: Image of SMS blast (2)	77
Figure A-16: Site hardening	78
Figure A-17: Pictures of a temporary placement centre	79
Figure A-18: Number of telecom sites.....	81
Figure A-19: Number of telecom sites requiring action	81

Figure A-20: Situation of sites in insecure areas as at 30 June 2022	85
Figure A-21: Evolution of the number of telecommunication sites out of service due to the security situation 2019-2022	86
Figure A-22: Evolution of the number of telecommunication sites out of service due to the security situation in 2022	87
Figure A-23: Architecture	88
Figure A-24: Division of responsibilities	89
Figure A-25: Information website for COVID-19.....	109
Figure A-26: Website of MA SANTÉ.CI.....	110
Figure A-27: Screenshot of a sticker	110
Figure A-28: Screenshot of a test result	111
Figure A-29: Scheme of the process.....	111
Figure A-30: Spectrum analyser with directive antenna	123
Figure A-31: Spectrum analyser operation.....	123
Figure A-32: Analysis of uplink frequencies	123
Figure A-33: Locating and digging operations in the rescue areas.....	124
Figure A-34: Image of UAV	125
Figure A-35: Image of telecommunication networks using UAVs.....	126
Figure A-36: Different types of links for HAPS communication	128
Figure A-37: Comparison of NTN D2D communications	128
Figure A-38: Shipboard base station	130
Figure A-39: Image of lightweight integrated satellite base station.....	133
Figure A-40: Connection between lightweight integrated satellite base station and core network through HTS	134
Figure A-41: Three principles of disaster preparedness.....	135
Figure A-42: Large-zone base station	136
Figure A-43: Region affected by the 14 August 2021 earthquake.....	144
Figure A-44: Noto Peninsula earthquake	148
Figure A-45: Communication network recovery	149
Figure A-46: Recovery activities	149
Figure A-47: Support at evacuation centres.....	150
Figure A-48: Disaster radio communication simulation scheme	154
Figure A-49: Disaster radio communication simulations.....	154
Figure A-50: Image of eDK.....	161
Figure A-51: Four phases of disaster risk management	162
Figure A-52: Qualitative and quantitative components of the ROI model	165

内容提要

国际电联电信发展部门（ITU-D）第1研究组很高兴与大家分享关于第3/1号课题“利用电信/ICT减少和管理灾害风险”的最后报告。报告延续了前一研究期（2014-2022年）以来第5/2号课题的灾害相关研究。本报告基于成员国和ITU-D部门成员在2022-2025年研究期内提交的文稿和互动讨论成果。报告概述了用于减少和管理灾害风险的电信/信息通信技术（ICT），并描述了各主管部门和组织在所有灾害阶段应用新兴ICT的一系列技术和政策案例研究。

全球气候变化导致自然危害的规模和严重程度逐年加剧。灾害会对社会造成重大负面影响，扰乱社会和经济生活的正常运行。由于突发灾害无法预测，因此灾害复原力、风险减少和管理（包括早期预警和警报系统、灾害演习和演练、救灾通信技术和有利的政策）对于挽救生命和减轻社会负面影响至关重要。

电信/ICT在减少和管理灾害风险方面发挥着关键作用。有效减少和管理灾害风险需要各利益攸关方及时、有效地共享信息、经验和教训。在全球范围内，可利用ICT在灾害发生的各个阶段提供支持，从而减少灾害发生时的人员伤亡和财产损失。

有效的政策在国家应急通信计划（NETP）的总体设计和实施中至关重要。因此，应制定相应的政策并辅以相应监管环境，以促进和便利有效的备灾和应急响应。政策应涵盖应急通信系统的部署、早期预警、通信连续性，以及更有效的应急响应等方面。在制定政策时，应考虑通信的可及性，确保其具有包容性，覆盖社会各阶层。因此，及时掌握灾害通信技术的最新发展动态尤为重要，本报告第5章将对此进行介绍。

简单来说，本报告共分七章，主要内容如下：

- **第1章**概述了报告范围，并简要综述了电信/ICT在灾害管理全周期中的作用。
- **第2章**探讨了早期预警与警报系统，分析ICT在系统规划中的应用；该章还讨论了为减少灾害风险部署早期预警系统、紧急警报广播系统、灾害信息和救灾系统的相关问题。
- **第3章**总结了准备和开展复原力和压力测试相关灾害演习和演练导则。
- **第4章**全面概述了有利的政策和监管环境，包括关于部署应急通信和早期预警系统、支持通信连续性和促进更有效响应的政策。
- **第5章**讨论了救灾通信技术和网络复原力。
- **第6章**介绍了基于ITU-D成员文稿的各类国家和行业案例研究。
- **第7章**讨论了确定的最佳做法和经验教训，以及研究期内建议的导则。

缩写词和首字母缩略语

缩写词	术语
AI	人工智能
BTK	土耳其电信监管机构
CAP	通用警报协议
CB	小区广播
CBS	小区广播业务
COTS	商用现成
COVID-19	2019年冠状病毒病
CREWS	气候风险早期预警系统
D2D	直接到设备
D2H	直接到手机
DCM	灾害通信连接图
EECC	《欧洲电子通信法》
ETC	应急通信项目组合
EW4ALL	联合国全民早期预警系统
EWBS	紧急警报广播系统
EWS	早期预警系统
FG-AI4NDM	国际电联“人工智能促进自然灾害管理”焦点组
GIS	地理信息系统
GSMA	GSM协会
HAPS	高空平台系统
ICT	信息通信技术
IoT	物联网
ITU	国际电信联盟
ITU-D	国际电联电信发展部门
ITU-R	国际电联无线电通信部门
ITU-T	国际电联电信标准化部门
LB-SMS	基于位置的短信
M2M	机器对机器

(续)

缩写词	术语
MNO	移动网络运营商
MWC	世界移动通信大会
NETP	国家应急通信计划
NGO	非政府组织
PPDR	公共保护和救灾
QoS	服务质量
RIFEN	国际女性数字专家网络（缩写为法文）
ROI	投资回报
SAS	南亚卫星
SDG	联合国可持续发展目标
SIDS	小岛屿发展中国家
SMART	科学监测与可靠电信
SNS	社交网络服务
TTX	桌面模拟演练
UAV	无人机
UDSEP	国家地震战略和行动计划
UNDRR	联合国减少灾害风险办公室
UNISDR	联合国国际减灾战略
VTOL	垂直起降
WFP-ETC	由世界粮食计划署牵头的应急通信集团
WMO	世界气象组织
WRC	世界无线电通信大会
WSIS	信息社会世界峰会
WTDC	世界电信发展大会
WTSA	世界电信标准化全会

第1章 – 引言

1.1 背景

国际电联全权代表大会、世界电信发展大会（WTDC）、世界电信标准化全会（WTSA）和世界无线电通信大会（WRC）的各项决议以及国际电联电信发展部门（ITU-D）、电信标准化部门（ITU-T）和无线电通信部门（ITU-R）发布的报告，均强调了电信/ICT在备灾、早期预警、救援、减灾、救灾和响应中的作用。此外，信息社会世界峰会（WSIS）行动方面、联合国可持续发展目标（SDG）、多项联合国国际减灾战略（UNISDR）决议和《2015-2030年仙台减少灾害风险框架》均认识到，减少灾害风险和建设可持续和有复原力的基础设施十分必要，以及ICT在提供人道主义援助、公共保护和救灾方面的重要作用。

为提升国家和区域对自然危害和人为灾害¹的备灾能力，国际电联一直倡导将电信/ICT用于备灾、减灾、响应和恢复，并为此鼓励区域和全球开展协作以及分享经验。在上一研究期（2018-2021年），ITU-D第5/2号课题审查了早期预警系统、以及备灾，及灾害通信计划、管理和响应的多个方面[b-Q5/2最后报告]。在2022-2025年研究期内，第3/1号课题强调电信/ICT技术（包括新技术）在减少和管理灾害风险中的应用，重点关注复原力。

1.2 报告范围

本报告旨在提供将电信/ICT应用于早期预警、灾害响应和救援（包括网络基础设施复原力）以及确保支持快速部署和实施的监管环境等方面的最佳做法和经验教训。本报告包含各国在备灾、减灾和灾害响应方面的经验和案例研究。关于国家灾害通信计划的制定，本报告研究了它们的共同主题和最佳做法。本报告涵盖四大领域：

- 早期预警和警报系统；
- 复原力和压力测试的演习和演练；
- 有利的政策和监管环境；
- 救灾通信技术和网络复原力。

相关案例研究和最佳做法总结见附件1，并在相关章节中引证。

¹ 根据联合国减少灾害风险办公室（UNDRR）见<https://www.undrr.org/our-impact/campaigns/no-natural-disasters>，应避免使用“自然灾害”这一术语。灾害是自然危害与脆弱性共同作用的结果。灾害是自然危害与导致灾害事件的人为和环境因素相互作用的结果。

1.3 国际电联决议和国际电联其他部门的可交付成果

国际电联有关灾害管理的决议如下：

国际电联全权代表大会

- 第136号决议：将电信/信息通信技术用于人道主义援助以及监测和管理紧急和灾害情况，包括与卫生相关的紧急情况的早期预警、预防、减灾和赈灾工作
- 第182号决议：电信/信息通信技术在气候变化和环境保护方面的作用

世界电信发展大会（WTDC）

- 第34号决议：电信/信息通信技术在备灾、早期预警、救援、减灾、赈灾和灾害响应方面的作用
- 第66号决议：信息通信技术、环境、气候变化和循环经济

世界无线电通信大会（WRC）

- 第646号决议：公共保护和救灾
- 第647号决议：针对紧急和灾害早期预警、灾害预测、发现、减灾和救灾工作的无线电通信问题（包括频谱管理指导原则）
- 第673号决议：地球观测无线电通信应用的重要性

世界电信标准化全会（WTSA）

- 第73号决议：信息通信技术、环境、气候变化和循环经济
- 国际电联关于灾害管理、网络复原力和应急通信的建议书和报告由ITU-T和ITU-R研究组制定。例如，ITU-T第2研究组（电信和ICT运营方面）是电信/ICT用于救灾/早期预警、网络复原力和恢复的牵头标准化研究组，牵头国际电联制定支持用于救灾/早期预警、网络复原力和恢复相关标准的工作，制定了关于救灾行动的国际应急优先方案的ITU-T E.106建议书，其中规定了在灾害情况下确定呼叫优先顺序的方法，通过清除非紧急呼叫，确保电信网络仍可用于紧急通信。

1.4 ICT与灾害管理和救灾

灾害管理涵盖灾前的备灾和灾后的救灾工作。如下节所述，ICT可应用于灾害管理的各个阶段。人工智能（AI）等新兴ICT正在逐年发展，这些新的ICT可能会在未来几年改变灾害管理和救援的模式。为在灾害发生时更高效地挽救生命，需持续收集有关将新的和新兴ICT用于灾害管理和救灾的信息。

1.5 ICT在灾害管理与智慧可持续发展中的应用

灾害风险管理流程**[b-NETP]**包含四个阶段：减灾、备灾、响应和恢复。ICT在灾害管理的四个阶段均发挥着关键作用。

减灾阶段：包括旨在预防紧急情况、降低其发生的可能性，或限制不可避免威胁的负面影响的所有行动。物联网（IoT）可帮助监测环境和潜在危害，大数据可用于分析有关潜在灾害的信息。

备灾阶段：相当于为应对应急事件而进行的规划和准备。人工智能可用于危害预测预警，小区广播则可用于向公众发布预警和警报。

响应阶段：在灾害管理的这一阶段，一切活动都旨在为受灾人群提供及时援助。ICT用于收集和分析灾害情况信息，努力保障通信畅通，确保第一响应者和公民之间及时进行重要信息交流。

恢复阶段：重点关注将社区恢复至紧急情况前或更好状态。ICT可帮助评估受灾地区和民众的受损情况和需求，跟踪灾后恢复进度，并协调重建工作。

智慧可持续发展与人为因素和利益攸关方协作密不可分。这需要克服若干关键挑战，包括制定机制，改进参与应急ICT响应的众多利益攸关方之间的协调；制定必要的融资策略以建立有效伙伴关系并确保可预测和灵活融资；确保志愿者培训计划的有效性并扩大志愿者交流网络；以及建设区域网络的能力并挖掘其专长。此外，除其他外，还必须采取措施发展公私伙伴关系，以促进区域和全球合作机会；打造更广泛的灾害管理平台，从而确保灾害通信救援服务随时可用；预先制定解决方案，避免在现场临时制定解决方案上浪费时间；以及建立适当的监管框架，促进救灾工作。针对这些要点采取的行动将有助于实现可持续发展目标（SDG）。

1.6 有利的政策和监管环境

灾害管理已经从一个具体的技术研究领域发展成为当今的跨学科方法，在有效的灾害管理中，有利的政策和监管环境同样重要，甚至更为重要。有效和实际的灾害管理不仅依赖于技术研究和设备，而且依赖于灾前、灾中和灾后每个阶段的程序原则、标准、指导以及职责和权限分配。

1.7 人为因素和利益攸关方协作

灾害不分国界。为减轻损失，包括国家、区域和地方各级政府、外国援助和救助组织、非政府组织（NGO）和民间团体组织、私营部门实体、志愿者和公民行动团体在内的各利益攸关方，都需要做出贡献。所有灾害都具有局部性，因为灾害发生时，邻里是第一响应者，而人们也会自然而然地首先寻求自救。ICT有助于解决这一现实问题，使人们能够跨越监管环境实现自助或互助。为此，应在公民和地方政府的帮助下，预先绘制有关易受灾害影响地区及疏散和收容地点的危险地图，并制定防灾计划。

在处理灾害情况时，人为因素和利益攸关方协作非常重要。在演习和演练过程中，需密切监测沟通协调方面的表现；发现任何不足都应及时纠正并记录，同时需要制定关于该主题的相关标准操作程序或导则。

另一个需要考虑的因素是，在灾难发生后，女性比男性更脆弱，死亡风险更高。与此同时，女性在建设抗灾能力方面是至关重要的合作伙伴。女性的视角与经验，以及她们组织、游说和传递信息的能力，能够极大推动灾害风险管理议程的进展。然而，现存的种种障碍限制了她们保护自身安全的能力，也阻碍了她们在灾害管理周期的各个阶段参与决策制定。

第2章 – 早期预警和警报系统

早期预警系统（EWS）由来已久。最早的预警装置是从太平洋沿岸文化以及非洲和美洲地区的原住民那里继承下来的，是基于对预警信号的目视观测。这些祖先的观测原则在今天仍然适用，并能更好地了解自然危害的诱因，以及部署更先进的传感器和通信技术，将数据传输至国家观测站，EWS得以改进，监测风险范围也得以扩大^{2,3}。

灾害管理界已认识到EWS的重要性，《2015-2030年仙台减少灾害风险框架》在优先事项4“改进备灾以作出有效响应，并在复原、恢复和重建中让灾区“重建得更好””和目标G“到2030年大幅增加民众对多风险EWS以及信息和灾害风险评估结果的获取”明确提及了这一点。国际社会也认识到EWS在应对气候变化方面的相关性以及通过《巴黎气候协定⁴》（第7条第7款c项）做出此类努力的必要性。

联合国减少灾害风险办公室（UNDRR⁵）将EWS定义为“一个集风险监测、预测与控制；灾害风险评估；信息传递和备灾活动于一体的综合系统，使个人、社区、政府、企业等能够在危害事件发生前及时采取行动降低灾害风险”⁶。

如第5/2号课题2018-2021最后报告[b-Q5/2最后报告]所述，电信/ICT在灾害前、期间、后期发挥着至关重要的作用，可为灾害准备、预测、预警、响应和恢复等各阶段提供支持。预警系统已被公认为是应对洪灾、旱灾、暴风雨、森林火灾及其他危害（地震、海啸）时挽救生命的重要工具。过去50年间，极端水文气象事件造成的经济损失增长了近50倍，但全球人员伤亡却减少了近十倍，这意味着近几十年来挽救了数百万条生命。最近几十年间，各国采用了不同技术和举措来部署早期预警和警报系统。

2.1 ICT在规划早期预警系统中的应用

灾害管理采取的策略基于以下认识：灾害不可避免，尽早采取适当预防措施将能挽救生命财产、减少大规模影响、提供即时救援，并有助于减轻未来类似灾害的影响。在灾前、灾害期间和灾后及时传播相关信息至关重要。有效的灾前预警宣传应具备在灾害发生时发布预警信息的能力和手段。必要时，迫在眉睫的危险预警必须尽快传达给相关区域的所有人员。地理信息系统（GIS）软件、卫星地球观测系统、人工智能、物联网、利用大数据和先进计算的实时分析、移动通信技术、社交媒体、机器人和区块链等技术的应用，均可有助于灾害管理，并开辟更可持续、更有复原力和更强劲的发展前景[b-Q5/2最后报告]。

² UN-SPIDER: <https://www.un-spider.org/risks-and-disasters/early-warning-systems>

³ 非盟: <https://www.undrr.org/sites/default/files/2023-10/the-africa-multi-hazard-early-warning-and-early-action-system.pdf?startDownload=true>

⁴ 巴黎协定: https://unfccc.int/sites/default/files/french_paris_agreement.pdf

⁵ UNDRR: <https://www.undrr.org/>

⁶ <https://www.un-spider.org/fr/node/12211#no-back>

2.1.1 联合国全民早期预警举措

联合国秘书长在2022年联合国气候变化大会（COP-27）上发起的全民早期预警举措⁷（简称“EW4A举措”）展示了预警如何拯救生命，并将在气候变化加剧、极端天气事件和自然灾害日益频发的背景下继续发挥作用。EWS作为一项气候变化适应措施，预计能产生十倍的投资回报。

联合国“全民早期预警举措”的四大支柱如图1所示：

图1: 联合国全民早期预警举措的四大支柱



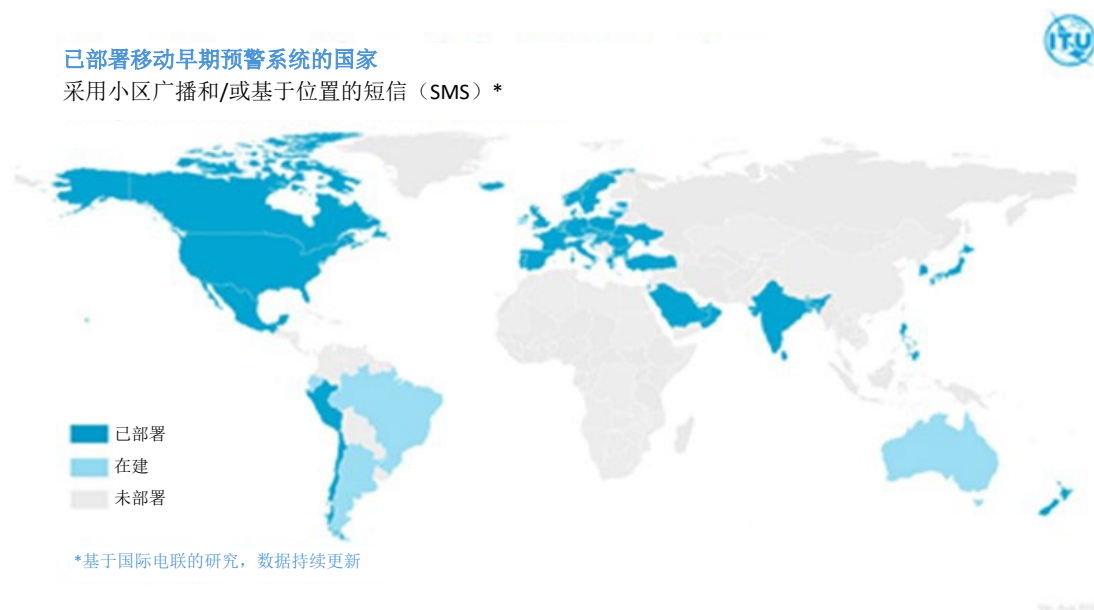
根据联合国秘书长在COP-27上的讲话，“人类半数人口正处于危险地带。气候热点地区的脆弱社区正遭受接踵而来的气候灾害的突袭，却没有任何预警手段。”他呼吁所有利益攸关方共同参与新的EW4ALL举措，该举措规定到2027年全球每个人都需受到EWS的保护。

国际电联在红十字与红新月联合会（IFRC）、风险知情早期行动伙伴关系（REAP）、联合国开发计划署（UNDP）和世界气象组织（WMO）的支持下，主导全民早期预警举措的“预警发布与传播”⁸支柱工作，重点关注最后一英里的连接，确保预警能及时传达给处境危险人群，以便采取行动。在预警传播方面不存在放之四海皆准的方法，我们需要应对处境危险社区的多样性。因此，国际电联提倡采用多渠道方法，通过广播、电视、社交媒体、警报鸣笛、手机、卫星等不同通信渠道发送警报，并赞同采用包容、以人为本的方式，利用现有的社区基础设施和当地主导的反馈机制，确保信息易于理解和采取行动。

⁷ 全民早期预警（EW4ALL）举措：<https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Early-Warnings-for-All-Initiative.aspx>

⁸ 预警发布与传播：<https://www.itu.int/hub/2023/01/early-warning-systems-mobile-connectivity/>

图2: 移动网络和服务的发展为早期预警带来新机遇



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当前，数字发展为在灾前、灾害期间和灾后更快、更有效地覆盖数十亿人口提供了新机遇。根据国际电联的《2023年事实与数字》，⁹全球95%的人口可以使用移动宽带网络，78%的人口拥有一部手机。这使得移动网络成为警示民众即将发生危险的极其强大的通信渠道。COP 27期间发布的该举措“行动计划”¹⁰呼吁推广和实施基于地理位置的移动预警服务，采用CB和/或基于位置的短信（SMS），作为“预警发布与传播”的关键要素。

小区广播或基于位置的SMS预警可精准定位风险区域人群。这些技术已在多个国家得到验证并应用，发出的警报可根据用户语言等特定需求进行调整。

2.1.2 用于减灾、响应和恢复的卫星

显然，电信/ICT在提高早期预警和计划系统的有效性和影响力方面发挥着关键作用。它们能实时收集、分析和传播重要信息，帮助预测并主动应对危机，从而挽救生命并减轻灾害影响。

在数据收集和分析方面，电信/ICT可以提供：

- 传感器与监测网络：通过气象站、地震仪、卫星图像、社交媒体和现场报告等多种来源实时采集数据，然后分析这些数据，以识别潜在风险并触发预警。
- 地理信息系统（GIS）：GIS使地理空间数据得以可视化并进行分析，更易于在发生灾害时识别易受影响区域、规划疏散路线及管理救灾资源。

⁹ 《衡量数字发展：2023年事实与数字》：<https://www.itu.int/itu-d/reports/statistics/facts-figures-2023/>

¹⁰ EW4ALL举措行动计划：https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Documents/2023/Executive_Action_Plan_en.pdf

在通信和信息传播方面，电信/ICT可以提供：

- **EWS：**可利用ICT通过短信、移动应用、警报鸣笛，及广播和电视等各种渠道向民众快速发布警报信息；
- **社交媒体与网络媒体：**可用于发布警报、传播灾害实时信息、收集灾情报告及动员救援力量。

这一现实在“变革性连接：卫星讲习班”报告中得到特别强调。该报告重点阐述了技术（特别是卫星）在灾害响应中的作用。讲习班第三场讨论了卫星通信如何助力灾害管理各个阶段的工作，包括减灾、响应和恢复阶段。特别突出了在其他地面通信基础设施瘫痪、受损或不存在时，卫星在灾害期间的复原力表现。尽管存在诸多挑战，但ICT在早期预警和规划系统中的应用，通过数据收集和分析及信息传播，对提升防灾备灾和响应能力具有巨大潜力。

2.2 部署降低灾害风险的早期预警系统

未来五年内，地球上的每个居民都应受到此类EWS的保护。在EW4ALL举措下，国际电联**电信发展局**¹¹正在努力通过以下措施向各国提供支持：国家应急通信计划（NETP）¹²；开发在线培训模块；开展应急通信能力建设活动；部署卫星设备等灾害响应行动；使用灾害通信连接地图来绘制灾后服务中断的通信基础设施；及参与减灾专题跨部门会议。目前已有30个国家¹³从国际电联电信发展局提供的此类支持中受益。

在日本，¹⁴L-Alert系统为900多家注册机构提供信息服务，包括电视台、广播电台、网站和防灾应用程序，这些机构都向当地居民传递信息。L-Alert系统也将在印度尼西亚共和国部署。确保灾害相关信息的可靠和快速分发是各国共同面临的紧迫问题。

为提高服务交付和效率，**不丹王国**¹⁵决定所有包含高度敏感数据的政府系统都应使用具有复原力且稳健的数据中心，以确保安全和提供防护。为此，政府数据中心应运而生。

2.3 广播紧急预警系统

为向广大民众提供紧急警报，电视和广播等服务既要高效又要确保易于使用。

¹¹ 见A1.7.6：电信发展局关于应急通信工作（包括活动、重大活动和资源）的报告<https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Response.aspx>

¹² <https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/NETPs.aspx>

¹³ 孟加拉、马尔代夫共和国、尼泊尔联邦民主共和国、老挝人民民主共和国、柬埔寨王国、基里巴斯共和国、萨摩亚、所罗门群岛、斐济共和国、汤加王国、吉布提共和国、索马里联邦共和国、苏丹共和国、乍得共和国、科摩罗、埃塞俄比亚联邦民主共和国、利比里亚共和国、马达加斯加共和国、毛里求斯共和国、莫桑比克共和国、尼日尔共和国、南苏丹共和国、乌干达共和国、圭亚那、海地共和国、巴巴多斯、安提瓜和巴布达、危地马拉共和国、厄瓜多尔。中亚：塔吉克斯坦。

¹⁴ 见A1.1.14：日本的L-Alert系统（日本）

¹⁵ 见A1.1.5：电信/ICT用于减少和管理灾害风险（不丹）

在日本，JTEC¹⁶引入了紧急警报广播系统（EWBS），该系统是数字地面广播系统（ISDB-T）灾害信息服务的一部分。利用地面广播无线电波的EWBS-CAP混合传输系统正在开发之中，而且正在就发展中国家将紧急警报广播系统纳入无线电广播系统的最佳方法开展研究活动。

EQ4ALL有限公司¹⁷通报指出，韩国科学技术信息通信部在全国范围内运行着一个包容性“紧急灾害报警系统”。该系统将汇总所有灾害信息，并以通用告警协议（CAP）格式发送给广播公司，然后广播公司将自动显示带有字幕的信息。

不丹¹⁸报告称，南亚卫星（SAS）地面台站网络在国家灾害通信战略中发挥着至关重要的作用。SAS地面台站网络用于广播和灾害通信的双重用途功能，凸显了卫星基础设施在应对多国挑战方面的多功能性。

2.4 早期预警与警报系统技术

Everbridge One2many¹⁹在基于位置的短信（LB-SMS）解决方案（在澳大利亚、瑞典、挪威、新加坡共和国和爱沙尼亚）、基于CAP的解决方案（例如荷兰王国、毛里求斯共和国、西班牙、挪威、沙特阿拉伯王国）和基于小区广播的解决方案（已为37家移动运营商客户）中完全采用多渠道方法。

基于位置的SMS（LB-SMS）项目虽然可行，但由于其复杂性且缺乏标准化，导致实施周期较长。因此，每家移动运营商都需要进行不同的集成工作，要么与运营商现有的定位探测器对接，要么在每个移动网络中部署新的定位探测器，以便发布新的Alert-SMSC，或者与现有的短消息服务中心（SMSC）集成。这些项目十分复杂，因为在LB-SMS领域有许多不同的活跃供应商（至少有40或50个不同的供应商），且部分集成方案需要与移动运营商特定的开发一起实施，导致项目高度定制化。LB-SMS领域的许多供应商使用不同的协议和集成方式。最终，用于公共预警系统的LB-SMS解决方案尚未得到任何标准化机构的标准化，因此LB-SMS项目非常复杂，交付周期较长（至少一年），而且每次部署都需要一种定制的方法。

对于公共告警系统而言，小区广播（CB）是一种更简单的方法。CB是得到电信行业全力支持的3GPP、ETSI和ATIS标准化解决方案，交付时间相对较短，复杂性较低，因为所有无线接入网（RAN）厂商都支持CBC 3GPP标准。CB是一种更适合在“全民早期预警”举措所针对的发展中国家实施的技术，因为它是一种完全标准化的“普通”实施方案（实施过程中不会出现意外情况），每个国家采用类似的方法，并且能够实现更可预测的项目时间表。

对于多信道方法，建议将OASIS定义的CAP标准作为另一种标准化的解决方案。CAP接口可作为默认集成，通过网站、移动应用、广播、电视、短信、WMO、数字白板等进行公共预警。在许多国家，CAP也被证明是一种简单、易部署和标准化的公共预警接口，可迅速（在2-3个月内）用于和/或集成到任何公共预警解决方案中。另一个优势是

¹⁶ 见A1.1.6: 紧急警报广播系统（EWBS）（日本）

¹⁷ 见A1.1.7: 实现包容性通信的电视平台（大韩民国）

¹⁸ 见A1.1.8: 利用南亚卫星（SAS）向农村地区提供国家电视和广播业务（不丹）

¹⁹ 见A1.1.9: 小区广播（CB）警报（Everbridge One2many）

CAP还可以用作默认接口，用于政府域和电信公司域（小区广播实体和小区广播中心）之间的集成。

印度²⁰已部署了一套系统，能够通过小区广播将关键和时间敏感信息分发给特定地理区域的移动设备，用于灾害管理。这是对现有的基于CAP的早期预警传播系统“SAmekit CHetavani Tantra（SACHET）”的改进。

2.5 早期预警和遥感系统

灾害探测是减灾和灾害风险管理的关键问题之一。为了探测海洋区域的灾害和海啸，葡萄牙²¹在葡萄牙与亚速尔群岛和马德拉群岛（CAM）之间部署了科学监测和可靠电信（SMART）电缆系统，称为SMART CAM。葡萄牙现有地震监测网络显示，对于该国西南部地区，地震EWS可以为采取减灾措施提供足够的预警时间。海啸EWS亦在考虑中，若实施可能将预警时间提前数十分钟。需注意的是，ITU-T第15研究组（SG15）²²正在编制ITU-T G.smart建议书。

日本国家信息通信技术研究所（NICT）²³开发了使用基于人工智能图像处理的视觉物联网（IoT）系统，该系统采用商用现货（COTS）组件构建，能够以相对较低的成本检测野火等自然灾害。通过利用现有视频监控摄像头和低成本的单板计算机，该系统可同时适用于发达国家和发展中国家。

印度²⁴引入了地球观测系统，通过卫星观测地球和气象运动，帮助人们应对天气挑战，因为它能够同时观测整个地球的天气状况。这是天气科学的一次小革命，通过持续收集地球的卫星图像来准确地预报降雨、风暴、飓风、沙尘暴等天气，因此，该系统可被视为EWS，有助于缓解天气/地质危害的有害影响。

中国²⁵还开发了光纤传感技术，用于检测和定位管道泄漏地点，作为光纤传感风险感知预警解决方案的一部分。该解决方案具有行业领先的识别精度，可广泛应用于油气管道风险感知和预警场景，具有采集全面、识别准确、学习快等优势。

2.6 灾害信息和救灾系统

在紧急情况下以最快速度提供准确信息，并在灾害发生前建立完善的信息系统，是高效灾害管理的基本要素。

虽然电信行业的动态发展和科技进步正在带来人们所期望的变革，但政府和相关利益攸关方在更好地预测和预防灾害方面仍需取得进展。因为无论灾害预测和预防技术如何进步，仍然存在一些薄弱环节。以最快速度向所有可能的受灾人群提供信息，对于预防灾害和减轻后果至关重要。在预警发布与传播过程中，多渠道方法可提高预警的有效

²⁰ 见A1.4.8：通过通用警报协议（CAP）平台利用小区广播提高公众意识（印度）

²¹ 见A1.1.10：SMART CAM海底电缆系统（葡萄牙）

²² 见A3.5：海底光纤电缆系统的特点（ITU-T第15研究组）

²³ 见A1.1.11：用于灾害检测的可视化物联网系统（NICT）

²⁴ 见A1.1.12：地球观测：在印度的作用、预测和救援（印度）

²⁵ 见A1.1.13：光纤传感技术在管线风险感知预警中的应用（中国）

性，并有助于解决处境危险社区的多样性问题。数字化转型为强化联合国“全民早期预警举措”的这一支柱带来了巨大的机遇，并使能够通过ICT（例如向手机发送警报）覆盖更多人群²⁶。ICT在减少灾害风险和管理方面发挥着至关重要的作用，特别是对更易受自然灾害影响的发展中经济体而言。RIFEN（国际女性数字专家网络）²⁷指出，ICT通过加强通信系统，有助于完善EWS，改善风险评估数据收集，并帮助有效协调救援工作。物联网技术还通过增强数据收集、实时通信和态势感知，在灾害管理和应急规划中发挥作用。在灾害期间，物联网有助于响应者之间快速共享信息，从而协调工作和高效部署资源。灾后阶段，物联网技术可协助损害评估和恢复工作，最终增强复原力和对未来灾害的准备水平。

有鉴于此，信息系统的设计应确保所有人都能获取预警信息，并能充分理解预警内容。在这种情况下，有效的早期预警服务应通过以下方式实现：让所服务的社区参与共同设计，建立反馈机制，确保信息通过人们偏好且信任的通信渠道以可操作的形式传达。同时，还应解决妇女、青年、儿童、残疾人、流离失所者、原住民和边缘化族群在接收、理解和响应早期预警服务行动时经常面临的结构性不平等问题。²⁸

土耳其²⁹制定了《2023年国家地震战略和行动计划》（UDSEP-2023）³⁰，旨在预防或减轻地震可能造成的物质、经济、社会、环境和政治破坏与损失，并建立新的抗震、安全和可持续的生活环境。UDSEP-2023是一项示范性研究，其中包含旨在最大限度减少地震损失的战略方法和行动顺序，目前已在落实相关行动方面采取了关键步骤。

科特迪瓦³¹在环境与可持续发展部的倡议下，正在开发国家气候多灾种监测和EWS。该系统将具备地理维度，以支持全国范围内的灾害响应。该系统的设计将借鉴由以下国家实体运营的水文气象、农业气候和环境数据收集站收集的数据和指标：

- 机场运营与气象航空活动发展协会（SODEXAM）
- 国家民防局（ONPC）
- 公园和保护区办公室（OIPR）
- 国家遥感和地理信息委员会（CNTIG）

科特迪瓦目前尚未制定支持灾害期间部署和使用ICT的监管框架或通用电信政策。尽管如此，ICT仍是该国防灾和早期预警活动的核心：

- 公共当局和救灾组织创建了**社交媒体网页**，并通过这些网页向公民发出警报和灾害预警。例如，**警方紧急情况Facebook页面**可向公民发出警报，**SODEXAM的Facebook页面**可发布天气预警，**ONPC-科特迪瓦的Facebook页面**则可提供全国范围内与家庭事故、交通事故和工业事件相关的灾害信息和预警。
- **移动通信技术**：向用户发送短信天气预警。

²⁶ https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000030011PDFE.pdf（第5页）

²⁷ 见A1.1.3：了解ICT如何在多灾种早期预警系统中发挥重要作用（RIFEN）

²⁸ https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000030011PDFE.pdf（第7页）

²⁹ 见A1.1.1：紧急情况中的信息系统（土耳其）

³⁰ <https://deprem.afad.gov.tr/content/75>

³¹ 见A1.1.2：见加强科特迪瓦制度框架和数字技术的使用以减少灾害风险（RIFEN）

- **通过广播电视传播公共服务公告和警报：**已采取音频描述、字幕和手语翻译等措施确保信息的无障碍获取。

科特迪瓦的灾害风险管理受政府制定的法律和制度框架约束，旨在加强该国的灾害预防和响应能力。为此，该国已经建立了致力于减少灾害风险的战略和实体。尽管尚未通过有关应急通信管理的法律框架，科特迪瓦已在使用电信技术在发生灾害时提供早期预警。

肯尼亚红十字会³²采用综合性的灾害管理方法，重点利用技术手段在全国范围内预防和减轻人类痛苦。他们强调使用Mapathons来绘制洪水易发区等高风险地区以及学校和医院等关键基础设施的地图，从而在灾害期间实现循证决策和有效资源分配。针对县政府工作人员的移动数据收集和管理方面的能力建设培训课程，对于加强地方复原力工作至关重要。卫星图像和无人机技术在灾害评估和响应中发挥关键作用，包括根据洪水影响预置资源、监测蝗灾等。该组织开发基于定向融资的EWS，体现了其主动防灾备灾的承诺，以减轻灾害影响并优化应对策略。强调持续收集社区反馈和开展能力建设是确保数字化转型倡议有效性和可持续性的关键要素。

2.6.1 灾害通信连接图（DCM）

灾害通信连接图（DCM）³³是国际电联和应急通信集团（ETC）在GSM协会（GSMA）参与下发起的一项联合举措，该举措于2020年启动，通过实时地图提供灾害期间现场可用连接的类型、级别和质量信息。DCM团队持续测试和评估其他连接数据源，开发高分辨率移动覆盖平台，并添加过滤器以进一步提高所显示数据的准确性。

2023年2月6日土耳其和阿拉伯叙利亚共和国发生地震后，国际电联启动了DCM。DCM可生成近乎实时的数据，以识别灾害后的连接缺口和中断情况，其数据已提交给ETC的合作伙伴和急救人员，在2月的前两周内，DCM已被来自42个国家的用户访问近1 000次，其中主要访问量来自土耳其境内。DCM数据显示，网络覆盖率显著下降：地震发生后，连通率仅为正常蜂窝覆盖范围的79%，中断主要发生在人口稀少的农村地区。在此之后，通信稳步恢复，已超过灾前覆盖水平的90%，但仍有部分区域未检测到正常连通状态。

DCM已经启动，以支持瓦努阿图共和国的救灾工作，该国先后遭受四级强热带气旋“朱迪”和“凯文”袭击。这两场气旋分别于3月1日和3日登陆，约有25万人受影响。强风和大量降雨引发严重洪灾、造成建筑物和基础设施损毁，并导致电力中断和通信系统瘫痪。在两个热带气旋过后，蜂窝网络覆盖面积下降，3月3日通信连通率仅为正常水平的36%，随后自3月6日起的一周内才逐步恢复。

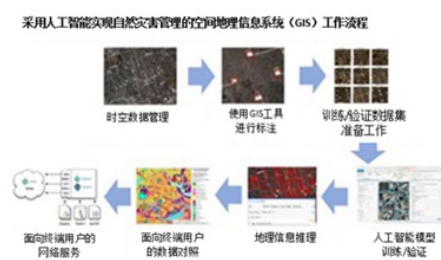
³² 见A4.2：灾害管理和复原力讲习班

³³ 见A1.7.6：见电信发展局关于应急通信工作（包括活动、重大活动和资源）的报告和<https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Disaster-Connectivity-Maps.aspx>

2.6.2 人工智能促进有效通信

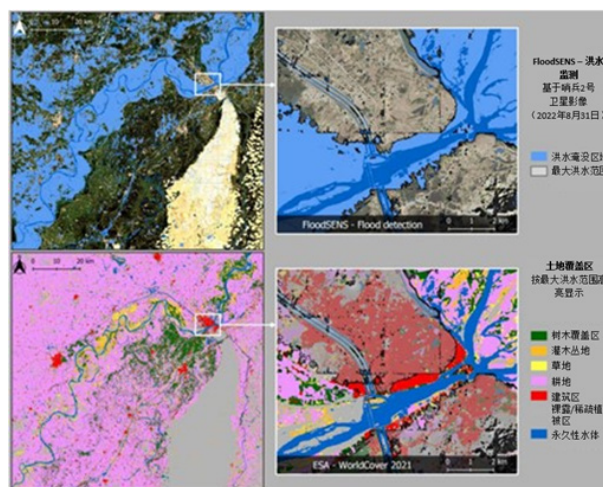
人工智能可以增强人类的灾害管理能力。然而，需充分认识并解决人工智能的局限性方能有助于发挥实效³⁴。国际电联人工智能促进自然灾害管理焦点组（FG-AI4NDM）“关于人工智能促进有效通信的技术报告”涵盖了最佳做法、摘要和用例的见解³⁵。该报告包含了几个关于如何使用人工智能的示例，通过各工作组的交付文件，阐述了人工智能应用于灾害管理的最佳做法。例如：地理信息系统（GIS）使用人工智能将地理信息可视化，如下所示，系统绘制数据地图并为终端用户创建网络服务，以向终端用户提供灾害信息。

图3：采用AI实现地理信息可视化的GIS工作流程



报告同时收录了2022年巴基斯坦洪灾的示例地图可视化案例。据报告，该洪灾为使用机器学习算法FloodSENS检测发现的，并基于欧空局（ESA）最新全球土地覆盖分类数据，根据洪水影响范围分析了受灾区域地表覆盖状况。³⁶

图4：2022年巴基斯坦洪灾地图



2.6.3 与灾害早期预警和告警系统相关的其他活动和会议

ITU-D电信发展局应急通信处在推动将ICT用于全球备灾和灾害响应方面取得了重大进展。国际电联积极参与了重大的国际和区域性活动，包括2023年、2024年和2025年世界移动大会（MWC），在会上重点介绍了移动技术在早期预警和应急协调方面的关键作用，并强调了在联合国“全民早期预警”（EW4All）举措下与移动网络运营商的合作。

国际电联还展示了其灾害通信连接图（DCM）及其如何发展成为早期预警通信连接图，这是一个与微软人工智能向善实验室、Planet和华盛顿大学健康度量与评估研究所（IHME）合作开发的人工智能工具。该地图可可视化显示移动网络覆盖区域内的人口分布及数量，同时标注连接“冷点”区域，这些区域的人口无法接收移动警报。过去三年间，已有33个国家使用这一工具绘制了地图。电信发展局还一直在推广基于移动的早期预警系统，如CB，以增强向风险人群发布警报的能力。

³⁴ <https://aiforgood.itu.int/wp-content/uploads/2020/12/Nature-Communications-Facilitating-adoption-of-AI-in-natural-disaster-management-through-collaboration-Kuglitsch-et-al-24Mar2022.pdf>（第1页）

³⁵ https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000030008PDFE.pdf（第2页）

³⁶ https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000030008PDFE.pdf（第9-10页）

在东盟应急通信网络大会、人道主义网络与伙伴关系周、加勒比地区灾害管理电信研讨会（与ETC和GSMA联合举办）、信息社会世界峰会（WSIS）、人工智能向善峰会以及CAP实施讲习班等活动中的参与，巩固了合作伙伴关系，并提升了国际电联在推动国家应急通信计划（NETP）、人工智能促进早期预警和利用ICT减少灾害风险领域的领导地位。值得注意的是，国际电联支持通过多利益相关方进程制定的索马里NETP启动并获得通过，随后举办了国家CAP讲习班以提升应急通信能力。

2024年全年，国际电联通过制定、完善并实施定制化的NETP和EW4All路线图，加大了对成员国的支持力度。吉布提、纳米比亚、坦桑尼亚、津巴布韦、卢旺达、科摩罗、圣文森特和格林纳丁斯、格鲁吉亚、利比亚及毛里塔尼亚的NETP已完成制定，冈比亚、佛得角、几内亚比绍和图瓦卢的NETP正在制定中。在科摩罗、吉布提、毛里塔尼亚、索马里及南共体地区举办的多方利益相关方讲习班，助力各国识别能力缺口、建立协调机制，并推进EW4All第三支柱（预警发布与通信）的实施。SADC示范NETP的发布为16个国家强化国家备灾和响应能力提供了框架。

通过在瓦伦西亚举办的跨机构ICT桌面模拟演练培训师培训（ToT），进一步加强了能力建设。该活动由UNICEF、WFP/ETC和GSMA联合举办，旨在提升应急通信准备能力。在WSIS论坛、CAP实施讲习班以及巴基斯坦人道主义连通性宪章讲习班等全球性活动中，国际电联作出的额外贡献彰显了其致力于加强数字复原力、促进区域协作、培育创新伙伴关系，以提升全球应急通信能力的坚定承诺。

在此进展基础上，2025年国际电联进一步扩大了在各区域的代表性，支持更多国家提升能力以强化应急通信和早期预警系统。在布隆迪、斐济、马拉维、加勒比地区及中亚举办的若干区域和国家讲习班，重点围绕EW4All举措下的实践培训、设备使用及跨部门协调展开。这些工作强化了政府、监管机构、私营运营商与人道主义机构间的协作，确保更多国家具备提供及时、可靠且以人为本的预警能力。2025年持续开展的活动彰显了国际电联的坚定承诺：通过提供必要工具、知识及合作伙伴关系，助力各国构建能够拯救生命的弹性通信系统。上述活动仅为部分示例，更多已公布活动的详情请访问：<https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Events.aspx>。

第3章 – 复原力和压力测试的演习和演练

3.1 应急通信知识和培训在线模块

培训为专业人员与民众提供预防、管理和减轻危机后果所需的技能，在灾害管理中发挥着根本性作用。它有助于提升对自然灾害（地震、洪水、火灾等）的防范能力，同时加强应急服务、政府机构与人道主义组织等关键行为体间的协调配合。通过适当培训，可以识别风险、制定应急预案并实施有效的响应策略。

随着电信/ICT的发展，在线培训已成为一种便捷且高效的解决方案，能够实现快速灵活的知识获取，帮助学习灾害管理方法。这种可及性对于从事人道主义或风险管理任务的专业人员和民众尤为宝贵，他们可在不中断工作的情况下接受培训。此外，在线培训通常成本更低甚至免费，使更多人能够在经济条件限制的情况下受益与此类培训课程。

远程教育的主要优势之一在于教学资源的丰富性与多样性。借助新技术，学员可通过包含解说视频、案例研究、模拟演练和实践操作的互动模块，更深入理解危机管理的挑战。这些资源会定期更新，以纳入风险管理和应急响应领域的最新进展。

2020年4月，土耳其³⁷推出远程学习平台，为公务员提供包括灾害风险管理在内的多样化培训。这一举措促进了机会平等，提高了公共培训的质量，截至2024年8月，已提供了超过3.6万个培训课程，培训了270多万名公务员。针对包括2023年地震在内的近期危机，该平台提供了灾害管理专项培训，增强了公务员对紧急情况的应对准备能力。这些培训课程涵盖15个主要培训类别，有效提升了机构和民众的防灾意识并强化了这方面的能力。

2021年1月，国际电联³⁸推出了国际电联应急通信在线培训模块³⁹。这些在线培训模块的开发与设计旨在帮助国际电联提升应急通信领域的能力建设与知识储备，即使在新冠肺炎疫情等特殊时期，也能持续增强灾害应对韧性。现有培训模块涵盖：(1) 基于国际电联国家应急通信计划（NETP）导则制定NETP⁴⁰；(2) 组织桌面模拟演练⁴¹（TTX）；(3) 关于坦佩雷公约⁴²及其效益的信息。所有三个在线模块均为自主进度学习，可在国际电联学院平台上获取。在本报告所述期间，共有398名学员参加了课程学习。

³⁷ 见A1.2.2：土耳其公共雇员在减少和管理灾害风险培训中有效使用ICT

³⁸ 见A1.7.6：电信发展局关于应急通信工作（包括活动、重大活动和资源）的报告

³⁹ <https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/ITU-Online-Modules-on-Emergency-Telecommunications.aspx>

⁴⁰ <https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Publications/Guidelines-for-NETPs.aspx>

⁴¹ https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Documents/Publications/2020/TTX_Guide.pdf

⁴² <https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/TampereConvention.aspx>

3.2 演习和模拟演练技术

模拟演练在评估和测试应急通信解决方案方面发挥着至关重要的作用。通过构建真实的危机场景，这些演练将通信系统置于极端或异常条件下，以测试其性能。它们能够验证网络复原力、解决方案的部署速度，以及确保各相关方之间最佳协调而制定的程序的有效性。这些模拟为评估基础设施承受破坏性事件的能力提供了实践框架，并衡量了通信至关重要情境下团队的响应能力。通过确定薄弱环节并提出改进建议，这些演练有助于完善响应战略和优化应急通信管理。**马来西亚**⁴³研究了电信服务在洪水发生时的复原力，**阿尔及利亚**⁴⁴则设计了应对森林火灾的活动。

通过模拟极端条件，这些演练不仅使团队为更有效的危机管理做好准备，同时增强了通信系统，以更好地应对紧急情况。

3.3 复原力讲习班

为了交流灾害管理信息，ITU-D组织的讲习班具有重要价值。**2023年5月和2024年4月**，第1研究组第3/1号课题组织召开了以“通过电信/ICT实现灾害管理和复原力”为主题的讲习班，重点交流了关于利用电信和ICT在面对灾害时保持通信复原力的经验和信息，包括使用当前和新兴技术支持成员国的努力。详情见附件4。

3.4 在灾害所有阶段提高ICT复原力方面吸取的经验教训

全球气候变化导致的极端灾害风险增加，要求加快提升应急通信团队能力和应急通信设备水平，并提升应急通信保障的效率和质量。**中国**⁴⁵从应急通信演习实践中总结了以下经验：

- 开展针对典型灾害场景的应急通信技能竞赛，提升应急通信团队专业化保障能力；
- 加强应急通信队伍协同作战能力，鼓励跨行业、跨企业的高效协作；
- 采取措施推动先进装备研发，应对极端灾害下的通信需求；
- 促进高科技装备的实际应用，提高应急通信保障效能。

萨摩亚独立国⁴⁶提议通过电信/ICT为小岛屿发展中国家（SIDS）采取多维度且具有复原力的方法，其中包括利用地面和卫星技术克服传统基础设施的脆弱性，并确保在紧急情况下实现持续通信。能力建设举措、伙伴关系以及政府、区域和国际组织以及私营部门之间的合作，对于加强灾害管理能力至关重要。

⁴³ 见A1.2.3：确保季风风暴和洪水期间电信业务恢复能力的措施（马来西亚）

⁴⁴ 见A1.2.4：森林防火（阿尔及利亚）

⁴⁵ 见A1.2.5：提高应急通信团队能力和应急通信设备水平的做法（中国）

⁴⁶ 见A1.2.6：通过电信和ICT增强太平洋小岛屿发展中国家的抗灾能力（萨摩亚）

第4章 – 有利的政策和监管环境

国际社会认识到，ICT在灾害管理的各个阶段（减灾、备灾、响应和恢复）发挥着重要作用，制定NETP对此至关重要，并且有必要将降低灾害和紧急情况风险的工作纳入可持续发展的政策、计划和项目中。法律法规的目的是促成有效的政策环境，因为这些法律法规确定了担任某些职务的个人的职责。

如何在发展中国家利用电信/ICT降低和管理灾害风险是一个复杂且包罗万象的问题。以下是这些国家在此领域面临的一些关键问题以及克服这些问题的战略：

基础设施有限：发展中国家往往缺乏基本的电信基础设施，如可靠的移动电话网络和互联网连接，这限制了在发生灾害时获得信息和通信的机会。

- 战略：投资发展基本电信基础设施，重点是移动技术和宽带网络，以改善农村和闭塞地区的连通性。

资源有限：发展中国家往往缺乏足够的财力、技术和人力资源，无法实施复杂的灾害管理技术解决方案。

- 战略：采用简单、经济的技术解决方案，如短信消息、“简易”移动应用和无线电通信系统，这些解决方案在资源有限的环境中更易于获取和部署。

数字素养水平低：发展中国家的许多居民数字素养水平低，信息技术经验有限，这可能会限制他们在灾害期间有效利用ICT的能力。

- 战略：教授采取符合当地人口ICT素养水平和需求的教学方法，引入关于ICT使用的提高认识和培训计划。

文化和语言障碍：文化和语言差异可能阻碍灾害预警消息和信息的有效传播。

- 战略：利用广泛使用的通信通道和针对具体区域的社交媒体渠道，使灾害预警消息和信息适应当地语言和文化背景。

参与者之间协调不力：政府、援助组织、民间团体组织和私营部门之间的协调可能不力，这可能导致灾害响应延迟以及信息技术使用低效。

- 战略：通过建立公私伙伴关系和鼓励交流信息和最佳做法，加强灾害管理各参与方之间的协调与合作机制。

刚果共和国⁴⁷总结了实际案例。

印度⁴⁸采取了积极主动的战略，以提高备灾和灾害响应的有效性，并加强电信基础设施的复原力。**科特迪瓦**⁴⁹采取举措，加强适用于降低灾害风险和灾害影响的法律和制

⁴⁷ 见A1.3.14：风险和灾害管理（刚果共和国）

⁴⁸ 见A1.3.7：为有效备灾和灾害响应及建设电信基础设施复原力而采取的预测和主动方法（印度）

⁴⁹ 见A1.1.2：加强科特迪瓦制度框架和数字技术应用以降低灾害风险（RIFEN）

度框架，强调了电信在早期预警过程中的重要性。为了更好地管理备灾、防灾和灾害响应工作，科特迪瓦政府制定了降低灾害风险的政策和框架，包括：

- 《国家降低风险和灾害战略》（SNRRC）；
- 建立国家降低风险和灾害平台（PN-RRC）；
- 创建多风险EWS的项目（SAP）；
- 在实施早期预警中有效利用通信和信息技术。

刚果民主共和国⁵⁰报告称，使用ICT是确保信息传输的有效工具，在危机时尤其如此。刚果民主共和国提供免费电话号码，并根据监管机构（刚果邮电管理局（ARPTC））为应对气候灾害（包括2021年的尼亚穆拉吉拉火山爆发）提出的建议，对电信/ICT服务开展免费促销方案。在**阿尔及利亚**⁵¹，作为防范森林火灾和提高阿尔及利亚国家森林公园内电信设施安全计划的一部分，邮政和电信部与林业总局以及固定和移动电话运营商合作，发起了一场重大的防火运动，其目的是在位于林区的电信站点实施森林防火措施。2022年，**澳大利亚**⁵²宣布了“澳大利亚地方和农村更好的连接计划”（“更好的连接计划”），以改善澳大利亚地方的连通性、目标生产力、服务公平以及社会和公共安全成果。“更好的连接计划”包括在五年内投入6.56亿澳元，用于改善澳大利亚农村和地方的移动和宽带连接以及复原力。这笔资金包括用于复原力发展计划的1亿澳元，如第2轮移动网络加固计划和电信抗灾能力创新计划。

4.1 应急通信系统部署政策

使用ICT是降低和管理自然危害造成的风险的有效且必不可少的工具。数字生态系统中的利益攸关方需要确保应急通信的可用性，并支持在该领域开展合作，实施灾害风险应对计划战略。以应对灾害管理的各个阶段，如预警、响应、救灾行动以及灾害之前、期间和之后的电信网络更新。其目的是与参与降低灾害风险领域的所有机构和组织实施协作式监管。

国家应急通信计划列出了确保通信在灾害各个所有阶段均可用的明确战略，促进各级政府、人道主义机构、服务提供商和处境危险社区之间的协调和参与。应急通信系统部署政策源自高级别政策声明、国家立法和（或）国家灾害风险管理计划，它们共同为政府和民间团体应对威胁或灾害的行动提供机构和机构间框架。

一些国家已制定此类政策框架。在**土耳其**⁵³，2014年制定了《土耳其灾害响应计划》（TAMP），以确保按照从以往灾害得到的经验对灾害作出有效响应。TAMP确定了将参与灾害和应急响应研究的工作组和协调部门的作用和职责，并确定了灾害之前、期间和之后响应计划的基本原则。TAMP包括政府部门、机构和组织，以及私营部门、非政府组织和个人，将参与应对土耳其可能发生的所有类型和规模的潜在灾害和紧急情况。

⁵⁰ 见A1.3.5：在刚果民主共和国（DRC）利用电信降低和管理灾害风险（刚果民主共和国）

⁵¹ 见A1.2.4：森林防火（阿尔及利亚）

⁵² 见A1.3.3：提高电信网络复原力以缓解和管理灾害风险的举措（澳大利亚）

⁵³ 见A1.7.1：2022年2月土耳其地震响应（土耳其）

2023年2月6日，土耳其发生了两次大地震：震中分别位于卡赫拉曼马拉什省的帕扎尔哲克区（震级：Mw 7.7；震源深度：8.6 km）和埃尔比斯坦区（震级：Mw 7.6；震源深度：7 km），地震发生时间分别为当地时间4时17分和13时24分。2023年2月20日，当地时间20时04分发生了另一场地震，震级为Mw 6.4，震中位于哈塔伊省的亚伊拉达厄。

由土耳其交通和基础设施部、土耳其国家电信监管机构（BTK）和运营商组成的“救灾通信小组”⁵⁴在TAMP框架内携手合作，从地震发生的第一刻起就开始投入工作。运营商被责成将所有拖车式移动基站运送到灾区。向灾区派出40台拖车式移动基站、500台移动基站、应急通信车和近2 200名人员，在地震灾区安装甚小孔径终端（VSAT）卫星终端和Wi-Fi接入点。

由于影响通信的主要问题之一是断电和燃料难以供应，因此向该地区运送了3 500台发电机。还为临时安置区提供了无线接入点，以满足互联网需求。

BTK的主要任务之一是保护消费者权益。在此背景下，为了立即做出响应，地震发生后，BTK委员会即于2023年2月14日做出了监管决定⁵⁵。相应的委员会决定建议运营商为受地震影响的消费者提供各种设施，例如：

- 向签约用户提供至少一个月的免费服务/福利。
- 将账单支付日期推迟至少一个月。
- SIM卡更换或服务地址变更不收取费用，提前终止承诺定期合同不收取费用等。
- 为在地震中丧生的签约用户结算与通信服务相关的账单/免除应收账款。
- 对于无法提供身份证件的用户，运营商将采用替代方法来验证用户身份，以便更换SIM卡/申请新SIM卡。

此外，一些新颁布法规的实施日期推迟了2至4个月，以激励运营商重点关注地震后应采取的措施。

除此之外，为了促进该地区的正常化和救灾工作，BTK学院移动技术卡车抵达该地区，为儿童提供编码、机器人技术等多项主题的培训。每天大约有150名儿童在BTK学院的移动教室接受培训。

地震发生后，责成运营商审查其业务连续性计划和在紧急情况下可供使用的资源。特别提请注意以下问题：

- 增加基站的冗余和光纤连接，特别是针对无线电链路连通的站点。
- 增加紧急情况下使用的移动基站、发电机和电池等资源。
- 在紧急情况下使用全国漫游访问
- 根据地理数据集和地图更新关键基础设施风险分析，并利用该数据重新安置高风险区域的基站。

⁵⁴ https://www.afad.gov.tr/kurumlar/afad.gov.tr/e_Kutuphane/Planlar/TAMP.pdf

⁵⁵ <https://www.btk.gov.tr/uploads/boarddecisions/deprem-felaketi-sebebiyle-alinacak-tedbirler/66-2023-web.pdf>

- 与当地能源供应公司共同审议供应计划，并采取必要措施，在灾害发生时为通信基础设施和系统提供持续的能源供应。

除此之外，在所有利益攸关方的参与下，土耳其的国家风险盾牌模型正在积极改进。

中国⁵⁶采取的政策包括成立特别项目，收集并推广用于典型灾害场景的应急通信技术和设备，协同联动开展防汛救灾应急通信保障。

刚果共和国⁵⁷报告称，国家应急计划应包括有关数据基础设施的建议。数据治理框架规定了哪些实体有权监测个人和非个人数据。这些框架还规定了数据的使用方式，并具体说明了数据管理和保护所需的人员、流程和技术。

各国应确保数据基础设施和流程按照商定模式负责任地处理数据。

弗洛明德基金会提供可安装在移动网络运营商（MNO）数据中心的开源代码，使其能够分析呼叫详细记录，从而追踪灾前和灾后的人口流动情况，并促进有针对性的救援行动。

降低和管理灾害风险不仅仅依赖于技术解决方案和具有复原力的基础设施。提高认识、备灾、社区参与和各利益攸关方之间的协作等人为因素在确保有效的灾害管理方面发挥着同等重要的作用。

日本⁵⁸注重公有管理机构与电子通信运营商之间的合作，以提高日本网络在2024年1月能登半岛地震期间的复原力。

在土耳其，**Turksat公司**⁵⁹一直在与政府机构（灾害应急管理局（AFAD）、红新月会）合作，建立备灾基础设施。这包括中心/移动协调中心、数据传输车辆和员工培训。Turksat公司优先考虑在灾害期间提供不间断通信。因此，该公司为政府机构提供连接服务，为基础设施受损的陆地移动网络运营商提供收容安置、公共通知和回程容量服务。

由以上可见，降低和管理灾害风险可以通过政府、国际组织、私营部门和民间团体等不同参与方之间的密切合作来实现。各参与方之间的沟通和信息交换对于更好地了解风险及其发生的可能性、共享经验教训和建设各利益攸关方的能力至关重要。

灾害风险的有效管理需要考量人为因素，并促进利益攸关方之间的协作。通过在提高认识、备灾、社区参与以及利益攸关方协作方面的投入，可建设社区复原力，并在利用ICT降低和管理灾害风险的过程中，为应对未来的挑战做好更有效的准备。

⁵⁶ 见A1.3.4：应急通信政策与防汛救援通信保障装备（中国）

⁵⁷ 见A1.3.6：国家应急通信计划：催化剂和保障（刚果共和国）

⁵⁸ 见A1.7.2：在日本建设具有复原力的基础设施/能登半岛地震的早期恢复响应（日本）

⁵⁹ <https://www.itu.int/pub/D-STG-SG01.01.03.05-2024>

4.2 促进早期预警、通信连续性和作出有效响应的政策

通用警报协议（CAP）[b-ITU-T X.1303]是一种简单而通用的格式，用于在各种网络上交换全灾种应急警报和公共预警信息。CAP能够将一致的预警信息同时通过多个不同报警系统进行传播，从而在减化预警工作的同时，提高预警的有效性。CAP还有助于发现本地各类预警信息中呈现出的新模式，这些模式可能暗示存在尚未被察觉的危害或敌对行为。CAP还基于学术研究和现实经验中确定的最佳实践，为有效的预警信息提供了模板。

2022年3月，联合国设定了一个新目标，确保到2027年，地球上的每个人都受到EWS的保护。整合应急警报的国际标准格式，以确保通过不同通信网络发出的警报具有互操作性和一致性，这对于以同样高的水平保护更多人将产生重大影响⁶⁰。

《欧洲电子通信守则》（EECC）第110条要求所有欧盟国家运行一个公共预警系统，该系统能够在自然或人为灾害发生时，可以向位于受影响区域的所有移动电话用户发送地理定位的紧急警报。几乎所有欧洲国家都已采用或正在选择（招标）EWS。已经选择了多种技术：小区广播（CB）和/或基于位置的SMS。这些EWS的有效性有赖于整个欧洲电信服务的良好接入和覆盖，其中99%的人口由4G网络覆盖。大多数欧盟国家要求在投标中符合CAP。

与世界上许多地方一样，澳大利亚⁶¹近年来经历了多次极端天气事件。在澳大利亚2019/2020年的夏季，在有记录以来最热和最干燥的一年之后，该国大部分地区遭遇严重森林火灾。这些森林火灾导致人员伤亡；估计有三十亿只动物死亡或流离失所；数千万公顷的土地和数以千计的财产遭到破坏。此后，一系列拉尼娜天气事件在2022年造成了严重的洪灾，影响了澳大利亚各地的许多社区。洪灾影响了许多澳大利亚人的日常生活，该国许多地区经历了有记录以来最潮湿的一年。澳大利亚联邦政府全面负责电信部门。这包括管理该部门的政策和监管环境，以及提供赠款资金，以鼓励扩大地方和偏远地区的移动网络覆盖等活动。然而，灾害响应的主要责任在于州和地区政府（共八个），而网络的直接运营和维护则由澳大利亚的电信运营商负责。这种责任划分意味着，当灾害发生时，电信运营商将根据管辖区内的应急管理安排，直接与相关州或地区政府合作。在此背景下，澳大利亚政府的主要作用是帮助电信部门为应对灾害和灾后恢复做好准备。

在实践中，州和地区政府经常与电信部门合作，为应对灾害做好准备。这包括让电信运营商参与应急规划。同时，澳大利亚政府在必要时向电信运营商提供广泛援助，以支持灾害响应和灾后恢复工作。例如，在2023年1月影响澳大利亚西北海岸的严重洪灾事件中，洪水冲毁了偏远地区一座架设有光纤电缆的重要主干桥，导致河对岸大断电，许多社区无法联系应急服务部门。对此，政府以军用航空器的形式提供援助，将一家电信运营商的技术人员运送到河对岸。这种支持使技术人员能够快速修复光纤连接并恢复连通性。

⁶⁰ https://www.itu.int/dms_pub/itu-d/oth/07/2e/D072E0000030011PDFE.pdf

⁶¹ 见A1.3.2：加强电信服务以应对自然灾害（STAND）（澳大利亚）

提高通信设施的复原力和快速恢复能力非常重要，**中国**⁶²正在开展以下任务来实现这一点：

- 根据灾害等级，修订和完善通信基础设施的技术要求和建设标准。
- 通过提升通信机房抗灾能力、增加传输手段、延长备用电池供电时间，推动运营商升级并共同建设移动通信超级基站。
- 开发、配备并储备更先进的通信设备，尤其是在易受灾害频发的地区部署独立于地面网络的卫星终端。
- 在应急通信团队中开展技能竞赛，并更频繁地组织跨企业、跨机构的协作演练和演习。

主要由于气候变化的影响，**科特迪瓦**⁶³如今是最易受到自然灾害影响的国家之一。为改进备灾、防灾和灾害响应管理工作，科特迪瓦政府出台了降低灾害风险的政策和框架，其中最值得注意的是：

- 国家降低灾害风险战略；
- 创建国家降低和管理灾害风险平台；
- 创建多灾种EWS的项目；
- 有效利用ICT提供早期预警。

国家应急通信计划（NETP）和其他国家协议和政策是指导应急通信准备和响应工作的基础。这些工作凸显了各国在如何实施其计划并增强国家和区域层面的复原力。然而，在制定国家应急通信计划之后，各国政府可以采取许多措施来实施国家和区域应急通信计划，并加强应急通信准备和抵御自然灾害的能力。根据WFP-ETC和GSMA⁶⁴的经验，以下关键点对于防备自然灾害十分重要。

- **加强国家和区域协调：**确定相关国家/区域机构、及联络点，关键是确保明确阐述和理解角色和职责。国家应急通信计划和应急通信标准运营程序（SOP）等政策机制可以在澄清流程、角色和责任方面发挥关键作用。举办各讲习班或活动有助于将相关利益攸关方联系起来。
- **进一步投资能力发展：**培训、能力评估和模拟演习，有助于确保相关政府利益攸关方在紧急情况发生前掌握必要的技能和知识 – 加大对这些活动的投资力度，对于培养国家应急响应人员至关重要。测试系统、协议和能力可以加强国家准备工作。
- **持续开展能力建设：**应每隔一段时间进行能力评估干预，以评估备灾情况，并推广培训师培训的学习方法，以便在工作人员流动的情况下保留制度性知识。

⁶² 见A1.3.4：应急通信政策与防汛救援通信保障装备（中国）

⁶³ 见A1.1.2：加强科特迪瓦制度框架和数字技术应用以降低灾害风险（RIFEN）

⁶⁴ 见A1.3.15：实施国家应急通信规划和加强国家与区域备灾工作（UN WFP-ETC，GSMA）

- 开展南南经验教训交流活动以分享知识：在全球范围内，政府利益攸关方还可以通过记录和传播经验教训、开展知识交流和进行同行学习的方式来相互学习。各社区可以汇集关键知识、资源和专长，以在未来提供更加协调一致的响应，包括利用区域能力（设备和应急响应人员）。
- 将应急准备纳入国家规划的主流工作：在国家规划中为应急准备干预措施提供充足的财政拨款，对于确保干预措施的长期可持续性至关重要。它还为国家规划周期提供了一个以可持续方式处理长期发展干预措施的机会，其中可包括加强早期预警基础设施等承诺。

第5章 – 救灾通信技术

5.1 ICT促进灾害管理和智慧可持续发展

5.1.1 监测和感知技术

在灾害中利用测向技术拯救生命

可以通过无线电测向在反向链路（上行链路）频率上定位移动电话信号来探测灾害受害者。在巴西⁶⁵圣保罗州圣塞巴斯蒂安的Vila do Sahy村，巴西国家电信管理局（ANATEL）采用了救援程序，其中包括利用连接到频谱分析仪的定向天线手动搜索接收信号最大电平的方向。带有定向天线的频谱分析仪如图5所示。

图5: 配有定向天线的频谱分析仪



ANATEL使用带有定向天线的频谱分析仪，该定向天线被调谐到用于蜂窝移动网络上行链路的以下频段：703-748 MHz、824-849 MHz、890-910 MHz、1 710-1 785 MHz、1 895-1 900 MHz、1 920-1 975 MHz、2 500-2 570 MHz。

这些程序在减少干预地区以找到偏远地区失踪的幸存者和遇难者方面发挥了有效作用。相关文件中提及，ANATEL技术人员使用的频谱分析仪在缩小干预区域和识别失踪人员方面发挥了关键作用。民防部门报告称，在Vila do Sahy村受灾害影响区域计划开展活动的时间被缩短到原分配时间的三分之一。民防部门还指出，Anatel所做的工作将与未来的救援活动结合起来。Anatel成立了一个研究委员会，负责制定技术规范和行动计划，详细研究圣塞巴斯蒂安未来救援活动中适用的活动和程序。

5.1.2 通信技术

用于应急通信的垂直起降固定翼无人机的高空平台系统（HAPS）

在应急通信场景中，基于中型垂直起降（VTOL）固定翼无人机（UAV）平台的高空平台系统（HAPS）能够通过卫星通信实现航空器控制和链路回程。能够利用机载基站快速恢复灾区本地通信，并可搭载吊舱传输实时视频和红外探测数据。相比于卫星解决方案，HAPS具备容量更高、延迟更低、穿透性更强等独特优势，因此它不仅可以确保消息

⁶⁵ 见A1.4.1：巴西圣保罗市圣塞巴斯蒂安Vila do Sahy村应用的救援程序

和语音等基本通信业务，还可以提供广泛区域内移动互联网和娱乐等更丰富的业务。在灾害发生时，HAPS可以迅速抵达受灾地区立即恢复通信。

拖曳式无人机通过电缆与地面连接，并通过光电复合电缆提供持续的电力供应。然而，如果道路中断，拖曳式无人机只能到达灾区边缘，无法迅速进入灾区中心区域，以便恢复通信。大型固定翼无人机需要大型机场，成本高昂，需要由高端专业操作人员操作，使用难度较大。而中型垂直起降固定翼无人机解决方案更为实际可行，因其不需要专用机场，因此操作更简便，更适合应急通信场景。

中国移动⁶⁶推出了基于中型垂直起降固定翼无人机平台的HAPS。该系统可以通过卫星通信管理航空器控制和链路回程，在灾区发生断联、断电、交通中断的情况下，利用机载基站快速恢复本地通信，并可搭载吊舱传输实时视频和红外探测数据。中型垂直起降固定翼无人机不需要专用机场，因此操作更简便，更适合应急通信场景。

用于应急通信的基于垂直起降固定翼无人机的HAPS概述：

- 中型垂直起降固定翼无人机的组成和特点

图6: 中型垂直起降固定翼无人机图像



- 中型垂直起降固定翼无人机高空基站的技术原理

图7: 使用垂直起降的HAPS图像



⁶⁶ 见A1.4.2：用于应急通信的垂直起降固定翼无人机的高空基站（中国移动）

- 扩大覆盖广度
- 超视距长距离飞行控制
- 提高移动性覆盖面
- 将指挥中心连接到现场
- 应用吊舱

软银公司⁶⁷介绍了HAPS，它安装于无人航空器上，该航空器在约20千米高度上的平流层静止旋转。在此高度上风速几乎没有变化，使HAPS能够极为稳定地飞行。由于翼展较大，HAPS可搭载高性能载荷和太阳能电池板，因此，其直径可达200公里，可长时间保持电力自给自足。

灾害发生后，受灾社区经常遇到通信中断问题，这阻碍了他们寻求援助、与家人联系或获取重要信息的能力。恢复通信需要部署通信基础设施和技术，以促进应急响应人员、受灾社区和相关机构之间可靠、及时的信息交流。HAPS旨在促进快速和有效通信，增强态势感知能力，协助搜救行动，并推动灾害发生后的恢复和重建工作。在关键的“黄金72小时”阶段，确保对被困在废墟下的人员进行准确救治并与之保持通信，意味着系统应具有能够支持视频通话的服务质量（QoS）。在这种紧急情况下，通过HAPS提供的覆盖，可实现有特定普及率需求的通信恢复。

图8: 系统比较



船载基站

KDDI公司⁶⁸（日本）介绍了2024年1月能登半岛地震响应中船载基站的应用案例。2024年1月6日，日本主要的移动通信运营商NTT Docomo公司和KDDI公司开始共同运营“船载基站”，即安装在船上的移动电话基站。该行动是NTT与KDDI于2020年签署的社会贡献合作协议的一部分，旨在应对社会问题，不仅涉及电信领域的联合协作，还包括灾害期间物资运输等行动。

⁶⁷ 见A1.4.3：高空平台台站（HAPS）系统（软银公司）

⁶⁸ 见A1.4.4：船载基站（日本，KDDI公司）

卫星通信

直接到设备（D2D）技术是一项新兴创新技术，旨在将连接扩展到传统地面网络无法覆盖的区域，特别是在基础设施可能遭到破坏或完全不可用的灾害场景下。通过实现与标准移动设备的卫星直接通信，D2D技术有可能在紧急情况下提供重要的生命线，确保用户即使是最偏远或受危机影响地区也能够发送遇险信号，接收警报，并保持基本通信。在其初始阶段，D2D服务的部署主要限于直接到手机（D2H）功能，特别强调应急通信消息传递。这种早期部署实现了基本的、基于文本的通信，使用户能够在蜂窝网络中断时请求帮助或了解最新信息。到目前为止，卫星通信采用主要集中于本就依赖星基通信的用户，例如徒步者、登山者、水手和经常在传统移动覆盖范围之外工作的远程工作者。这些人群以往依赖专用卫星电话或卫星支持的专门工具，但将D2D技术集成到主流智能手机有望扩大其可及性。

Access Partnership⁶⁹报告了D2H技术用于救灾通信情况，意在灾害发生时，将覆盖范围扩大到传统地面网络无法覆盖的区域。该业务的初始阶段主要提供有限的业务，重点关注应急通信消息传递。

中国移动⁷⁰介绍了一款轻便一体式卫星基站。该系统内置电池，可随时随地开启使用。卫星基站可以装在一个背包里，因而单人即可将其携带至灾害场所。

地面通信

NTT Docomo⁷¹（日本）报告了在发生大范围灾害和停电期间，使用大区域和中区域基站确保人口稠密地区的通信安全的情况。这些基站可提供360度覆盖，覆盖半径达七公里，比一个标准基站的覆盖面更宽广。

5.1.3 智能分析技术

应急通信集团（ETC）投资回报（ROI）模型

世界粮食计划署-应急通信集团（WFP-ETC）⁷²开发了一个投资回报率（ROI）模型，用于评估2021-2022年应急通信准备方面的投资效益，目的是生成成本效益的经验性证据，并最终鼓励人道主义发展利益攸关方建设更多具有抗灾能力的电信。

人工智能促进自然灾害管理

ITU-T第2研究组⁷³成立了“人工智能促进自然灾害管理”焦点组（FG-AI4NDM），旨在利用人工智能进行救灾和早期预警、网络复原和恢复方面的典型标准化前工作。该焦点组已结束工作并发布了若干可交付成果，如“人工智能促进通信用于自然灾害管理的技术报告”。

⁶⁹ 见A1.4.5：救灾通信中的直接到手机技术（Access Partnership公司）

⁷⁰ 见A1.4.6：轻便一体式5G卫星基站（中国）

⁷¹ 见A1.4.7：日本移动运营商备灾案例研究（日本，NTT Docomo公司）

⁷² 见A1.7.5：ETC投资回报（ROI）模型：为具有风险抵御能力的电信基础设施发展提供信息（WFP-ETC）

⁷³ 见A3.1：人工智能用于自然灾害管理（ITU-T第2研究组）

5.1.4 其他技术

通用警报协议（CAP）

印度⁷⁴介绍了基于CAP的早期预警传播系统，名为SAmekit CHetavani Tantra（SACHET）。该系统于2021年8月开始在泛印度实施基于CAP的早期预警传播系统项目，并于2023年8月成功完成。所有预警授权机构，包括内政部、国家灾害管理局和所有36个州的州灾害管理局，均已实现无缝整合。所有州灾害管理局（SDMA）都可以通过其仪表板直接发送地理定位预警，无需人工干预。

CB与CAP平台集成配对，为在灾害期间全面提高公众认识提供了一款强有力的工具，同时还可以传播短信，CB包含了在灾害情况下覆盖更多受众的独特能力。其覆盖范围广、定向传播和自动化的特点可确保关键信息传达给受灾地区的每一个人，从而有可能挽救生命并将灾害影响降至最低。CB与CAP平台集成配对的有效性在印度飓风“Michaung”期间成功得到证明。

5.2 具有复原力的通信基础设施

电信和ICT的使用为增强抗灾能力提供了巨大潜力。然而，RIFEN⁷⁵（国际数字技术女性专家网络）指出，克服可及性、协调和基础设施复原力方面的挑战亦至关重要。

海地⁷⁶介绍了其评估具有复原力的电信/ICT网络和基础设施的方法。在复原力方面，确定移动电话运营商和主要互联网接入提供商的整体恢复或重建能力在60%至75%之间。为确保在灾害及其后续阶段，电信网络不会遭受过度破坏，且可用性不会受到不必要损害，采取以下步骤是基础且合理的：

- 评估电信网络和基础设施遭到破坏所造成的影响；
- 评估运营商现有的恢复计划；
- 评估现有网络和基础设施的复原力水平；以及
- 提出解决方案，以改善恢复计划和电信网络和基础设施的现有复原力水平。

国际通信卫星组织（Intelsat）⁷⁷提出了通过电信/ICT增强灾害频发区域抗灾能力的全方位手段。通过同时使用地面和卫星技术，各国可以克服传统基础设施的脆弱性，确保紧急情况下的持续通信。

⁷⁴ 见A1.4.8：通过通用警报协议（CAP）平台利用小区广播提高公众认识（印度）

⁷⁵ 见A1.5.1：利用电信/ICT降低和管理灾害风险（RIFEN）

⁷⁶ 见A1.5.3：海地电信/ICT网络和基础设施的复原力

⁷⁷ 见A1.5.4：通过电信和ICT提高灾害易发地区的抗灾能力（Intelsat）

5.3 人为因素和利益攸关方的协作

早期灾后恢复响应

日本和日本KDDI⁷⁸通报了2024年1月1日能登半岛地震发生后电信网络的恢复响应情况。截至2024年1月18日，四家移动运营商NTT Docomo公司、KDDI公司、软银公司和乐天移动已完成紧急恢复任务，仅剩部分难以到达的地区尚未恢复，一旦道路打通，计划将尽快在这些地区恢复服务。紧急恢复指采取使网络暂时可用的措施，如“为因停电而无法运行的基站提供发电机”以及“为传输线路光纤被切断的基站提供卫星通信设备”。全面恢复的前景取决于每个地区相关基础设施（如道路、电力和光线路）的恢复状况。

从这次灾害的经验来看，当移动电话基站的光纤被切断时，卫星互联网设备（星链终端）被广泛用作替代。卫星互联网设备亦可用于在避难中心确保通信的一种手段。日本政府对灾害原因及其应对措施进行了必要核实，并考虑到在利用卫星和无人机等新技术以及公私合作方面取得的进展。将进一步努力加强通信环境，避免通信中断。

无线电通信仿真

印度尼西亚⁷⁹介绍了一项举措，组织若干利益攸关方参与救灾无线电通信仿真活动。该活动包括准备无线电通信程序、呼号、灾害数据和信息的传播以及灾害场景（灾前、灾中和灾后）。救灾无线电通信仿真提高了利益攸关方和社区在灾害管理和使用无线电通信方面的能力。使用共用频率使协调更加有效和高效。此外，还可以向公众传达可靠和有效的信息，避免欺骗和虚假新闻。

女性、ICT和应急通信

电信发展局和应急通信集团出版的“[女性、信息通信技术（ICT）和应急通信 – 机会与限制报告](#)”⁸⁰概述了突显性别数字鸿沟以及加大妇女和女童在灾前、灾中、灾后的脆弱性的一系列因素。它还展示了使用ICT促进灾害风险管理中的性别平等的良好做法和实例。

5.4 与灾害管理相关的其它报告

报告和从灾害中吸取的经验教训

土耳其⁸¹报告了2023年2月6日发生两次大地震后的情况，并建议运营商审查其业务连续性计划和资源，以便在紧急情况下使用。

⁷⁸ 见A1.6.1：在日本建设具有复原力的基础设施/能登半岛地震的早期恢复响应（日本）

⁷⁹ 见A1.6.2：通过无线电通信仿真加强利益攸关方和社区在降低灾害风险方面的协作（印度尼西亚）

⁸⁰ 国际电联和应急通信集团，[《女性、ICT和应急通信 – 机会与限制报告》](#)（2020年，日内瓦）。

⁸¹ 见A1.7.1：2022年2月土耳其地震响应（土耳其）

日本⁸²、KDDI⁸³和NTT Docomo⁸⁴报告了2024年1月1日能登半岛地震后的情况，并建议通过调动一切可能的手段开展工作，包括在灾害响应阶段使用船载基站从沿海地区发射无线电波，以及利用无人机技术用在该地区部署临时基站。

预防疫情

土耳其⁸⁵介绍了电子化合同终止服务，该服务能在难以进行线下接触（例如疫情期间）的情况下，确保对消费者的保护。

促进管理灾害的其他技术

卢旺达共和国⁸⁶介绍了使用无人机促进灾害风险管理的举措，这使其能够对空中勘察洪水易发地区、监测洪水易发地区和山体滑坡易发地区的河流水位。随着气候变化继续加剧灾害的频率和强度，卢旺达将继续投资于无人机等技术驱动的解决方案，以加强其灾害管理工作。通过应对监管和操作挑战，卢旺达可以制定使用无人机促进有效的灾害风险管理（DRM）、保护生命和确保可持续发展的最佳做法。通过使用人工智能、ICT和数据分析等先进技术，无人机能够成为在灾害期间改善态势感知和决策程序的宝贵工具。

⁸² 见A1.7.2：在日本建设具有复原力的基础设施/能登半岛地震的早期恢复响应（日本）

⁸³ 见A1.4.4：船载基站（日本，KDDI）

⁸⁴ 见A1.4.7：日本移动运营商备灾案例研究（NTT Docomo公司）

⁸⁵ 见A1.7.3：通过电子政务网关提供的电子化合同终止服务（土耳其）

⁸⁶ 见A1.7.4：将无人机纳入灾害风险管理（DRM）四个关键阶段的情况：减灾、备灾、响应和恢复（卢旺达）

第6章 – 国家和行业案例研究

本节总结本研究期内提交的有关第3/1号课题的国家和行业案例研究。案例研究分为五类：早期预警和警报系统、复原力和压力测试的演练和演习、有利的政策和监管环境、救灾通信技术等。本报告**附件1**载有对案例研究的详细介绍；**表1**列出了每个议题案例研究的标题、提交国家和在**附件1**中的相关小节。

表1：案例研究

议题	国家	实体	案例研究标题	小节
第2章：早期预警和警报系统				
2.1 ICT在早期预警和警报系统规划中的应用	土耳其	土耳其	紧急情况中的信息系统	A1.1.1
	科特迪瓦	RIFEN	加强科特迪瓦制度框架和数字技术应用以降低灾害风险	A1.1.2
	RIFEN		利用实时监测和ICT驱动的早期预警系统，加强备灾和灾害响应	A1.1.16
	肯尼亚	肯尼亚红十字会	技术在灾害管理中的应用	A4.2
2.2 部署早期预警系统以降低灾害风险	日本	日本	日本的L-Alert系统	A1.1.14
	土耳其	土耳其	土耳其的国家移动预警系统	A1.1.4
	不丹	不丹	电信/ICT促进降低和管理灾害风险	A1.1.5
	亚太电信组织 (APT)	亚太电信组织标准化计划 (ASTAP) 灾害风险管理与救灾系统专家组 (EG DRMRS)	使用无线电通信系统的早期预警系统	A3.4
	美国	美国国家海洋和大气管理局 (NOAA)	美国的移动警报	A4.1
2.3 广播应急预警系统	日本	JTEC公司	应急预警广播系统 (EWBS)	A1.1.6
	大韩民国	EQ4ALL有限公司	利用电视平台实现包容性通信	A1.1.7
	不丹	不丹	利用南亚卫星 (SAS) 向农村地区提供国家电视和广播服务	A1.1.8
	ITU-R	6A工作组	救灾国际电台 (IRDR)	A3.3
2.4 早期预警和警报系统技术	荷兰	Everbridge One2many公司	小区广播 (CB) 警报	A1.1.9
	印度	印度	通过通用警报协议 (CAP) 平台利用小区广播提高公众认识	A1.4.8

表1：案例研究（续）

议题	国家	实体	案例研究标题	小节
2.5 早期预警和遥感系统	葡萄牙	ANACOM公司	SMART CAM海底电缆系统	A1.1.10
	日本	日本国家信息通信技术研究 所（NICT）	可视化物联网系统促进灾害探测	A1.1.11
	印度	印度	地球观测	A1.1.12
	中国	中国	光纤传感技术在管线风险感知预警中的应用	A1.1.13
2.6 灾害信息和救灾系统	布隆迪共和国	RIFEN	ICT如何在多灾种早期预警系统中发挥重要作用	
	电信发展局（BDT）	第1/1、3/1和5/1号课题报告人	第1/1、3/1和5/1号联合课题卫星促进减灾、备灾、响应和恢复关于“变革性连接：卫星讲习班”的文件。 https://www.itu.int/md/D22-SG01-C-0346/en	A1.1.15
	联合国		联合国全民早期预警活动（称为EW4ALL）	A4.1
第3章：复原力和压力测试的演练和演习				
3.1 应急通信知识和培训在线模块	阿尔及利亚	阿尔及利亚	ORSEC救援计划启动	A1.2.1
	土耳其	人力资源办公室	在面向土耳其公职人员的降低和管理灾害风险培训中有效利用ICT	A1.2.2
	全球移动通信系统协会（GSMA）	GSMA	与移动运营商和政府开展救灾演练	A4.2
3.2 演习和模拟演练技术	马来西亚	马来西亚通信和多媒体委员会（MCMC）	确保电信业务在季风风暴和洪水期间的复原力而采取的措施	A1.2.3
	阿尔及利亚	阿尔及利亚	森林防火	A1.2.4
3.3 复原力讲习班			救灾讲习班	A4
3.4 在灾害各个阶段提高ICT复原力方面吸取的经验教训	中国	中国	提升应急通信队伍能力和技术装备水平的做法	A1.2.5
	萨摩亚	萨摩亚	通过电信和ICT增强太平洋小岛屿发展中国家的抗灾能力	A1.2.6

表1：案例研究（续）

议题	国家	实体	案例研究标题	小节
第4章：有利的政策和监管环境				
4.1 应急通信系统部署政策	布基纳法索	布基纳法索	布基纳法索电信基础设施的复原力	A1.3.1
	澳大利亚	澳大利亚	加强电信服务以应对自然灾害（STAND）	A1.3.2
	澳大利亚	澳大利亚	提高电信网络复原力以缓解和管理灾害风险的举措	A1.3.3
	中国	中国	应急通信政策与防汛救援通信保障装备	A1.3.4
	刚果民主共和国	刚果民主共和国	在刚果民主共和国利用电信降低和管理灾害风险	A1.3.5
	刚果共和国	刚果共和国	国家应急通信计划：催化剂和保障	A1.3.6
	印度	印度	为有效备灾和灾害响应及建设电信基础设施复原力而采取的预测和主动方法	A1.3.7
	巴西	Intelsat	加强监管和许可政策，通过电信和ICT确保灾害频发地区的复原力	A1.3.8
	刚果共和国	刚果共和国	风险和灾害管理	A1.3.14
	HAPS联盟	电信工作组	部署高空平台系统（HAPS）的监管环境	A3.10
	联合国	WFP	将备灾纳入国家规划	A4.2
4.2 促进早期预警、通信连续性和作出有效响应的政策	美国	Lumen Technologies公司	增强复原力的先进规划	A4.2
	布隆迪	布隆迪	利用ICT降低和管理灾害风险	A1.3.9
	塞内加尔	塞内加尔	包括与相关组织合作在内的新冠肺炎疫情行动计划	A1.3.10
	科特迪瓦	科特迪瓦	科特迪瓦新冠肺炎疫情响应计划	A1.3.11
	罗马尼亚	罗马尼亚	单一应急号码112	A1.3.12
	多米尼加共和国	多米尼加共和国	警报信息系统的新监管框架	A1.3.13
	联合国全球移动通信系统协会（GSMA）	WFP-ETC GSMA	实施国家应急通信规划和加强国家与区域准备	A1.3.15
	科摩罗联盟	科摩罗	在科摩罗实施NEPT	A3.12

表1：案例研究（续）

议题	国家	实体	案例研究标题	小节
第5章：救灾通信技术				
5.1 ICT促进灾害管理和智慧可持续发展	巴西	巴西国家电信管理局（ANATEL）	救援程序	A1.4.1
	中国	中国移动	用于应急通信的垂直起降固定翼无人机的高空基站	A1.4.2
	日本	软银公司	高空平台（HAPS）系统	A1.4.3
	日本	KDDI公司	船载基站	A1.4.4
	英国	Access Partnership 公司	救灾通信中的直达手机技术	A1.4.5
	中国	中国移动	轻便一体式5G卫星基站	A1.4.6
	日本	NTT Docomo 公司	日本的移动运营商备灾案例研究	A1.4.7
	印度	印度	通过通用警报协议（CAP）平台利用小区广播提高公众认识	A1.4.8
	美国	SES World Skies 公司	卫星通信在救灾通信技术中的作用	A1.4.9
	ITU-R	ITU-R 6A工作组	救灾国际电台（IRDR）	A3.3
	亚太电信组织（APT）	ASTAP EG DRMRS	APT国家的灾害信息共享系统	A3.4
	亚太电信组织（APT）	ASTAP EG DRMRS	灾害期间使用车辆的信息通信系统的要求	A3.4
	亚太电信组织（APT）	ASTAP EG DRMRS	APT区域便携式/可移动应急通信系统案例研究	A3.4
	ITU-T	第15研究组	宽带业务的光接入网拓扑	A3.5
	ITU-T	第15研究组	科学监测和可靠电信电缆系统	A3.5
	欧洲电信标准协会（ETSI）	应急通信技术委员会（TC EMTel）	应急通信规范	A3.7
	ITU-T	第21研究组（前第16研究组）	应急服务	A3.8
	HAPS联盟		为实现平流层生态系统而制定的HAPS行业和监管建议	A3.10
	ITU-T	第20研究组	物联网（IoT）的灾害响应与可持续智慧城市和社区（SSC&C）的灾害预防	A3.11
	塞内加尔	谢赫·安达·迪奥普大学	白点区域内的通信网络系统	A4.2

表1：案例研究（续）

议题	国家	实体	案例研究标题	小节
5.2 网络复原力	喀麦隆	RIFEN	利用电信/ICT降低和管理灾害风险	A1.5.1
	海地	海地	ICT基础设施和网络复原力评估：促进应急通信的方法	A1.5.2
	海地	海地	海地电信/ICT网络和基础设施的复原力	A1.5.3
	美国	Intelsat	通过电信和ICT提高灾害易发地区的抗灾能力	A1.5.4
	ITU-T	第11研究组	网络快速响应突发自然灾害	A3.6
	美国	联邦通信委员会（FCC）	灾害响应举措	A4.2
5.3 人为因素和利益攸关方的协作	日本	KDDI	在日本建设具有复原力的基础设施/能登半岛地震的早期恢复响应	A1.6.1
	印度尼西亚	印度尼西亚	通过无线电通信仿真加强利益攸关方和社区在降低灾害风险方面的协作	A1.6.2
	ITU-T	FG-AI4NDM/MM	人工智能用于通信，实现自然灾害管理	A3.1 A4.1
	ITU-R	5A工作组	网络快速响应突发自然灾害	A3.9
5.4 其他	土耳其	BTK	通信连续性和政策建议	A1.7.1
	日本	总务省（MIC） KDDI 软银公司 NTT Docomo	在日本建设具有复原力的基础设施/能登半岛地震的早期恢复响应	A1.7.2 A1.4.3 A1.4.7
	土耳其		通过电子政务网关提供的电子化合同终止服务	A1.7.3
	卢旺达		将无人机纳入灾害风险管理（DRM）四个关键阶段的情况：减灾、备灾、响应和恢复	A1.7.4
	WFP-ETC	WFP-ETC	应急通信集团投资回报（ROI）模型：为具有风险抵御能力的电信基础设施发展提供信息	A1.7.5
	ITU-D	BDT	电信发展局关于应急通信工作的报告，包括日常活动、重大活动和资源	A1.7.6
	中国	清华大学	ICT在紧急救援行动中的应用	A4.2

第7章 – 良好做法、导则和结论

如何在发展中国家利用电信/ICT降低和管理灾害风险是一个复杂且多面的问题。发展中国家在将电信/ICT用于灾害管理和减灾方面面临的主要挑战包括：**基础设施有限、资源有限、数字素养低、文化和语言障碍以及各参与方之间的协调不力**。第4章对这些挑战进行了讨论。

7.1 分析并确定最佳做法导则和吸取的经验教训

将电信/ICT用于灾害管理和缓解可能费用高昂，因此应考虑尤其是对发展中国家进行投资分析和评估。

如第5.1.4节所述，**WFP-ETC**⁸⁷制定了一个ROI评估模型，可用于计算应急通信准备投资的有效性。该文件介绍了在三个国家应用ROI模型的经验教训和良好做法，并指明了未来行动的关键方向。该模型使国家利益攸关方和国际社会能够根据可量化信息做出规划和决策，这些信息表明了应急通信准备方面投资的有效性。该模型有助于扩大对应急通信的投资。

从政府的角度来看，**不丹**⁸⁸介绍了加强降低和管理灾害风险的举措。铺设光纤的路权、复杂地形以及利益攸关方之间缺乏协调等挑战仍有待解决，以便最大限度地发挥电信和ICT在降低和管理灾害风险方面的益处。

在卫星技术方面，**国际通信卫星组织（Intelsat）**⁸⁹部署了利用地面和卫星技术，在灾害易发地区通过电信和ICT加强抗灾能力的工作，并分析了各国经验和良好做法。

ITU-D⁹⁰在应急通信领域向各国提供支持，包括提高认识、制定计划、培训、导则和工具包，以支持国家和区域在降低灾害风险方面的工作。**WFP-ETC**和**GSMA**⁹¹与国际电联合作，为众多政府的ICT机构、灾害管理机构和电信监管机构提供支持，使它们能够为灾害做好更好的准备。

7.2 ICT用于救灾、响应和恢复

电信/ICT正在成为灾害管理各个阶段中救灾、响应和恢复的重要工具。第2章至第5章描述了一些电信/ICT使用导则，但需要考虑更有效的方法和具体的要求。

⁸⁷ 见A1.7.5：应急通信集团投资回报（ROI）模型：为具有风险抵御能力的电信基础设施发展提供信息（WFP-ETC）

⁸⁸ 见A1.1.5：利用电信/ICT降低和管理灾害风险（不丹）

⁸⁹ 见A1.5.4：通过电信和ICT提高灾害易发地区的抗灾能力（Intelsat）

⁹⁰ 见A1.7.6：电信发展局关于应急通信工作（包括日常活动、重大活动和资源）的报告

⁹¹ 见A1.3.15：实施国家应急通信规划和加强国家与区域准备（UN WFP-ETC，GSMA）

RIFEN⁹²分享了有关在降低和管理灾害风险领域使用电信/ICT的信息。尽管取得了技术进步，但挑战依然存在，尤其是在危机情况下技术解决方案的可及性、可靠性和有效性方面。

萨摩亚⁹³在电信/ICT领域采取了举措，这些举措在减灾、备灾、响应和恢复方面发挥着关键作用，特别是在易受自然灾害影响的区域，如与太平洋区域接壤的小岛屿发展中国家（SIDS）。分享了利用地面和卫星技术，在太平洋小岛屿发展中国家通过电信和ICT加强抗灾能力的工作，并讨论了各国经验和良好做法。

刚果共和国⁹⁴强调，各国必须制定灾害应急计划，以便更好地进行管理，否则将面临人力和物力等诸多风险。还提到在此背景下，应指出，**GSMA**已为各国和监管机构制定了建议，鼓励它们在制定国家应急计划时，将有关个人数据管理政策纳入将电信/ICT用于灾害管理和缓解的工作。

7.3 其他无障碍获取方面的考虑

事实证明，电视是向失聪者传递社会价值的最有影响力的平台之一。随着技术发展，可以期待电视上的所有内容（包括灾害警报）都能自动翻译成虚拟形象手语。要实现最终这一目标，政府应大力支持人工智能（AI）训练数据集（手语和口语的平行语料库）和有效的翻译引擎。

大韩民国⁹⁵提供了两个案例研究，涉及使用最新的电视平台改善聋人对信息和通信的无障碍获取。第一个案例是关于利用安卓电视平台和人工智能技术，促进聋人和听力障碍者家庭成员和无听力障碍家庭成员之间的沟通，从而减轻其孤立感。第二个案例研究展示了如何通过无线网络和IP网络向聋人和听障人士有效传达灾害预警信息。这两个采用最新技术的案例研究将有助于更好地理解如何利用电视平台支持建设更具包容性的社会并实现可持续发展目标。

7.4 结论

电信/ICT在灾害情况下发挥着关键作用，可用于灾前收集信息、向民众发送救生警报、在受灾地区也要建立有意义的电信接入、灾后提供救灾解决方案等。本报告总结了电信/ICT在灾害管理和救灾中的应用案例研究和最佳做法，特别是EWS、救灾演练、政策法规、救灾通信和网络复原力。这些信息有助于制定国家救灾计划，在灾害发生时挽救生命。

然而，电信/ICT正逐年稳步发展，人工智能和IMT-2030（6G）等新兴技术将在不久的将来日益广泛地应用于灾害管理与救灾领域。因此，基于这些新技术的灾害管理解决方案也亟待深入研究与理解。

⁹² 见A1.5.1：利用电信/ICT降低和管理灾害风险（RIFEN）

⁹³ 见A1.2.6：通过电信和ICT增强太平洋小岛屿发展中国家的抗灾能力（萨摩亚）

⁹⁴ 见A1.3.6：国家应急通信计划：催化剂和保障（刚果共和国）

⁹⁵ 见A1.1.7：利用电视平台实现包容性通信（大韩民国）

请ITU-D部门成员和所有其他利益攸关方在其各自专业领域内、并与相关国家和地区组织一起，帮助提高认识并分享信息，以利用本地、国家和区域层面的知识，加快实施进程，共同努力，实现降低灾害风险、拯救生命的总体目标。

Annexes

Annex 1 – Case studies

A1.1 Early warning and alerting systems

A1.1.1 Information systems in emergencies (Türkiye)⁹⁶

Institutional setup in Türkiye

The Disaster and Emergency Management Agency (AFAD) in Türkiye, is an organization under the Ministry of Interior (MoI). After being restructured in 2022, the AFAD currently carries out its activities through its central organization, as well as through "Provincial Directorates of Disaster and Emergency" that are directly affiliated with governors in the provinces and "Directorates of Disaster and Emergency Search and Rescue Units" located in 16 provinces. The Ministry of Environment, Urbanization and Climate Change (MoEUCC), also has powers, duties, and responsibilities for studies to be carried out before and after disasters. These responsibilities include drafting legislation on settlement, environment, and land development; taking measures regarding urban regeneration and building inspection; ensuring the improvement of professional services; activities related to spatial planning, geological surveys, and geographic information systems; damage assessment studies; debris removal; infrastructure works; demolition of damaged buildings; prevention of environmental pollution and protection of nature; and combating climate change.

On the other hand, according to the land development legislation, it is the responsibility of metropolitan municipalities to make environmental plans that set out decisions on general land use for urban and rural settlements, development areas, and for sectors such as industry, agriculture, tourism, transportation, and energy. The metropolitan municipalities are also responsible for land development plans that envisage the general patterns for land use, the main zoning types, the population density of regions in the future, the trends, size, and principles of development for various urban and rural settlements, as well as urban, social, and technical infrastructure areas, and transportation systems. District municipalities are responsible for making implementation plans that determine land development requirements, such as building blocks, uses, building plans, building heights, floor area ratios, building coverage ratio or plot ratio, and building approach distance, as well as roads, pedestrian walkways, bicycle lanes, transportation relationships, parks, squares, and urban, social, and technical infrastructure areas. For other provinces, it is the responsibility of provincial municipalities to make development and implementation plans, while the MoEUCC is responsible for the preparation of environmental plans.

Disaster information and relief systems in Türkiye

The National Earthquake Strategy and Action Plan 2023, (UDSEP-2023), was prepared by AFAD to prevent or mitigate the physical, economic, social, environmental, and political damage and losses that may be caused by earthquakes and to establish new earthquake-resistant, safe, and sustainable living environments. Critical steps were taken to implement the actions defined in UDSEP-2023, which is an exemplary study that includes strategic approaches, and action sequences aimed at minimizing

⁹⁶ ITU-D SG1 Document <https://www.itu.int/md/D22-SG01.RGQ-C-0242/> from Türkiye.

earthquake losses. The ability of the information systems developed by various public institutions to work in an integrated manner is critical in disaster management. The information systems that are considered to be directly useful in the disaster management process in Türkiye are as follows:

- Disaster Management and Decision Support System Project⁹⁷ (carried out by AFAD)
- Spatial Address Registration System⁹⁸ (carried out by Mol)
- Turkish National Geographic Information System⁹⁹ (carried out by MoEUCC)
- e-Municipality¹⁰⁰ (carried out by Mol and MoEUCC)
- Mobilization Resource Planning System (carried out by AFAD and National Security Council)
- Village Infrastructure Support Project¹⁰¹ (carried out by Mol and MoEUCC)
- Geological Survey Information System (carried out by MoEUCC)

The Earthquake Department of AFAD shares details about earthquakes on its official website. There are multiple types of information systems provided by the AFAD earthquake department:

- earthquake reports¹⁰²
- press releases¹⁰³
- event web service¹⁰⁴
- notification services:
 - mailing list subscriptions¹⁰⁵
 - SMS list subscriptions¹⁰⁶
- "This Month in History"¹⁰⁷

The AFAD earthquake department also develops desktop and web-based geoscience applications and provides documents for a better understanding of the seismicity of Türkiye. Examples of such web-based geoscience applications include:

- Turkish Accelometric Database and Analysis System (TADAS)¹⁰⁸

⁹⁷ <https://www.afad.gov.tr/afet-yonetim-ve-karar-destek-sistemi-projesi-aydes21>

⁹⁸ <https://www.nvi.gov.tr/maks>

⁹⁹ <https://cbs.csb.gov.tr/tucbs-i-86080>

¹⁰⁰ <https://www.belediye.gov.tr/>

¹⁰¹ <https://koydes.csb.gov.tr/>

¹⁰² <https://depem.afad.gov.tr/earthquake-reports>

¹⁰³ <https://depem.afad.gov.tr/press-release>

¹⁰⁴ <https://depem.afad.gov.tr/event-service>

¹⁰⁵ <https://depem.afad.gov.tr/mail-application>

¹⁰⁶ <https://depem.afad.gov.tr/sms-resignation>

¹⁰⁷ <https://depem.afad.gov.tr/this-month-history>

¹⁰⁸ <https://tadas.afad.gov.tr/>

- Earthquake Data Centre System of Türkiye (TEDCS)¹⁰⁹
- Türkiye Earthquake Hazard Map
- Earthquake Parameter Estimation and Analysis System (DEKAS)¹¹⁰
- Seismo-geodetic Earthquake Analysis System (SIDAS)¹¹¹
- Rapid Earthquake Damage and Loss Estimation Software (AFAD-RED)¹¹²
- 6 February 2023 Kahramanmaraş Earthquake Clearinghouse¹¹³

A1.1.2 Strengthening the institutional framework and the use of digital technologies for disaster risk reduction in Côte d'Ivoire (RIFEN)¹¹⁴

Côte d'Ivoire experiences regular flooding and landslides, leading to regrettable loss of human life and material damage. Moreover, more than two-thirds of the coastline is affected by coastal erosion, which has an impact on industrial facilities and on public and private investments and, in turn, weakens the national economy. The Government of Côte d'Ivoire has therefore undertaken to improve its disaster preparedness, prevention, and response plan through the adoption of a legal and institutional framework focused on emergency communications, as early warnings can be effective in reducing the risks and consequences of disasters. To this end, a regulatory framework, and a number of general telecommunication policies will be developed to support the deployment and use of ICTs in general, and during disasters, in addition to a general disaster risk reduction framework.

Development of a legal and institutional disaster risk reduction framework in Côte d'Ivoire

Owing to the country's vulnerability to climate change, Côte d'Ivoire has taken the decision to develop a legal and institutional disaster risk reduction framework. This framework includes the following policies, institutions, and warning systems dedicated to reducing disaster risks:

- **The adoption of Decree No. 2012-988 of 10 October 2012, on the creation, remit, organization and functioning of the National Disaster Risk Reduction and Management Platform.** The role of the platform is to make disaster risk reduction a priority; to identify risks; to prevent and mitigate the impact of disasters; to raise awareness and promote education about disaster risks; to reduce the vulnerabilities of populations and the environment; to maintain response readiness; and to respond to disasters. The platform was officially launched on Thursday, 24 August 2023, when the first exchange of ideas between various stakeholders was held.
- **The introduction of the National Disaster Risk Reduction Strategy.** Drawn up in 2011, this strategy is currently being reviewed pursuant to a decision of the Council of Ministers adopted on 12 December 2020, with the support of the United Nations Development Programme. This review is in line with the African Union Africa Regional Strategy for

¹⁰⁹ <https://tdvms.afad.gov.tr/>

¹¹⁰ <https://deprem.afad.gov.tr/content/85>

¹¹¹ <https://deprem.afad.gov.tr/content/87>

¹¹² <https://deprem.afad.gov.tr/content/91>

¹¹³ <https://deprem.afad.gov.tr/assets/pdf/deprem-bilgi-destek-sistemi.pdf>

¹¹⁴ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0175/> from International Network of Women Digital Experts (RIFEN).

Disaster Risk Reduction. The operational framework for implementing the new National Disaster Risk Reduction Strategy should be centred around the implementation plan for the National Development Plan, the national decentralization policy and other relevant sectoral plans and policies. The actions set out in the National Disaster Risk Reduction Strategy, are founded on regional and international cooperation, and take a comprehensive and holistic all-hazards approach. The National Disaster Risk Reduction Strategy has four strategic axes:

Strategic axis 1: Understand disaster risks: This axis is developed by the National Disaster Risk Reduction and Management Platform;

Strategic axis 2: Improve the governance of disaster risk reduction by strengthening relevant legal and regulatory tools;

Strategic axis 3: Invest in economic, social, cultural, and environmental resilience;

Strategic axis 4: Improve post-disaster preparedness, response, and reconstruction.

Tools: EWSs in Côte d'Ivoire

EWSs can be used to warn, inform, and communicate effectively about approaching or ongoing disasters in order to reduce the risks or impact. All hazard prevention systems should be synchronized, taking into account a range of hazards and the needs of end users. In Côte d'Ivoire, at the initiative of the ministry responsible for the environment and sustainable development, a national climate-based multi-hazard detection and EWS is being developed. The system will have a geographical dimension to support hazard response throughout the country. The design of the system will draw on data and indicators gathered by hydrometeorological, agroclimatic, and environmental data-collection stations operated by the following national entities:

- **Society for the Operation and Development of Airports, Meteorology and Aeronautical Activities (SODEXAM).** SODEXAM is a national meteorological agency that operates 13 meteorology stations across the territory of Côte d'Ivoire. In the event of flooding or heavy precipitation, it supplies meteorological data to interministerial disaster management committees to enable the Government to take appropriate measures. With regard to early warning efforts, SODEXAM transmits weather forecast information to users, for example by sending SMS messages to users to warn them about weather changes and publishing alerts on its Facebook page (<https://www.facebook.com/SODEXAM>).
- **National Civil Protection Office (ONPC).** The ONPC is the national office responsible for implementing government policy on national protection. It provides data on previous disasters and their impact for use in compiling statistics. Within the framework of early warning efforts, the ONPC is working with SODEXAM to **raise awareness** and **provide information** about disaster risks. These activities are conducted via the ONPC website (<https://www.onpc-ci.org/>) and via the social media accounts of both organizations. The ONPC also provides first-aid training, including training on the provision of first-aid during disasters.
- **Office of Parks and Reserves (OIPR).** Responsible for the protection and sustainable management of biodiversity in Côte d'Ivoire, the OIPR provides information on the state of biodiversity in the country.

- **National Committee of Remote Sensing and Geographical Information (CNTIG).** The CNTIG is the country's source of expertise on geographical information systems, remote sensing and mapping applications, as well as new information technologies.

Use of ICTs in disaster risk reduction management and in EWSs

Côte d'Ivoire does not yet have a regulatory framework or any general telecommunication policies to support the deployment and use of ICTs during disasters. Nonetheless, ICTs are at the heart of disaster prevention and early warning activities:

- The public authorities and disaster relief organizations have created **social media** pages through which they provide citizen alerts and disaster warnings. For example, the **Police emergency Facebook** page provides citizen alerts, the **SODEXAM Facebook** page provides weather warnings, and the **ONPC-Côte d'Ivoire Facebook** page provides information and warnings about disasters linked to domestic incidents, traffic accidents and industrial events throughout the country.
- **Mobile communication technologies:** SMS weather warnings are sent to users.
- **The dissemination of public service announcements and alerts via radio and television:** Measures to ensure accessibility are applied, such as audio description, subtitling, and sign language interpretation.

Disaster risk management in Côte d'Ivoire is governed by a legal and institutional framework developed by the Government in order to strengthen the country's disaster prevention and response capacities. Strategies and entities dedicated to disaster risk reduction have been established to that end. Although a legal framework on emergency telecommunication management has yet to be adopted, Côte d'Ivoire is already using telecommunication technologies to provide early warnings in the event of disaster. EWSs seem to provide an effective and essential means of minimizing the risks and impact of disasters. It is therefore recommended that a legal framework should be adopted, that provides for the use of telecommunications in disaster prevention and response procedures in Côte d'Ivoire.

A1.1.3 How ICTs play an important role in multi-hazard early warning systems (RIFEN)¹¹⁵

Telecommunications and ICTs play a critical role in enhancing disaster risk reduction and management, especially in unpredictable scenarios caused by climate change.¹¹⁶ Through real-time data collection, EWSs, and efficient communication networks, ICTs facilitate rapid response and coordination during disasters such as droughts and floods. However, some countries still face challenges such as limited infrastructure, high costs, and digital divides that hinder the widespread implementation of these technologies. Strengthening local capacity, investing in technology, and fostering public-private partnerships (PPPs) can help improve disaster resilience across the continent. The use of Internet of Things (IoT) EWSs can be used to rapidly detect changes that signal potential disasters, such as earthquakes, floods, or severe storms allowing authorities to issue timely alerts to citizens and

¹¹⁵ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0368/> from International Network of Women Digital Experts (RIFEN)

¹¹⁶ Dwivedi, Y. K., Hughes, L., Kar, A. K., Baabdullah, A. M., Grover, P., Abbas, R., Andreini, D., Abumoghli, I., Barlette, Y., Bunker, D., Kruse, L. C., Constantiou, I., Davison, R. M., De, R., Dubey, R., Fenby-Taylor, H., Gupta, B., He, W., Kodama, M., Wade, M. (2021). Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. International Journal Of Information Management, 63, 102456. <https://doi.org/10.1016/j.ijinfomgt.2021.102456>

emergency services.¹¹⁷ This proactive approach enhances situational awareness, facilitates better resource allocation, and ultimately saves lives by enabling communities to prepare and respond more effectively to impending threats. Efforts to enhance disaster risk reduction and management in the African regions are increasingly focused on collaboration among governments, NGOs, and local communities, emphasizing the integration of ICTs. By leveraging ICTs, stakeholders improve data collection, risk assessment, and communication during emergencies, thus fostering a more resilient infrastructure. Initiatives such as workshops, training programmes, and the establishment of shared platforms aim to build capacity and enhance coordination, ensuring that communities are better prepared to respond to, and recover from natural disasters, while also addressing climate impacts.

The role of Internet of Things in disaster management and relief

IoT plays a pivotal role in disaster management and emergency planning by enhancing data collection, real-time communication, and situational awareness. Connected devices and sensors monitor critical conditions such as weather changes, infrastructure integrity, and population movements, providing valuable insights that inform decision-making. During disasters, IoT facilitates rapid information sharing among responders, enabling coordinated efforts and efficient resource deployment. Post-disaster, IoT technologies assist in damage assessment and recovery processes, ultimately strengthening resilience and preparedness for future events.¹¹⁸

Access to real-time information can dramatically improve response times and resource allocation during crises, thereby mitigating adverse impacts on health, food security, and economic stability. ICT plays a major role in disaster risk reduction and management by facilitating the development of EWSs that leverage multiple communication channels, such as radio, television, SMS, and Internet platforms. These systems enhance public awareness and preparedness by disseminating timely information about impending disasters, enabling communities to take proactive measures.

Early warning and alerting systems

EWSs leverage telecommunications/ICT to collect, analyse, and disseminate crucial information about weather and climate-related hazards, allowing communities to prepare for, and respond to potential disasters. By providing timely alerts, these systems enable individuals and organizations to take proactive measures, ultimately reducing vulnerabilities and enhancing resilience. The integration of technology in disseminating warnings through mobile alerts, social media, and community networks ensures that critical information reaches both authorities and affected populations. ICTs play a crucial role in multi-hazard¹¹⁹ s EWS by facilitating timely and effective measurements of environmental parameters such as seismic activity, rainfall levels, and air quality. When predefined thresholds are exceeded, IoT devices can trigger automated alerts through various communication channels, ensuring rapid dissemination of vital information to communities at risk. Additionally, real-time data analytics enable authorities to assess potential threats quickly, leading to proactive measures and coordinated emergency responses. This integrated approach not only saves lives but also minimizes economic losses during disasters.

ICT further supports response efforts through real-time data collection, coordination among agencies, and delivery of crucial information to affected populations, ultimately reducing the overall impact of disasters and improving recovery outcomes. IoT significantly contributes to disaster risk reduction

¹¹⁷ Miorandi, D., Sicari, S., De Pellegrini, F., & Chlamtac, I. (2012). Internet of things: Vision, applications and research challenges. *Ad Hoc Networks*, 10(7), 1497-1516. <https://doi.org/10.1016/j.adhoc.2012.02.016>

¹¹⁸ Sakurai, M., & Murayama, Y. (2019). Information technologies and disaster management – Benefits and issues -. *Progress In Disaster Science*, 2, 100012. <https://doi.org/10.1016/j.pdisas.2019.100012>

¹¹⁹ Shi, Y., Liu, X., Kok, S., Rajarethinam, J., Liang, S., Yap, G., Chong, C., Lee, K., Tan, S. S., Chin, C. K. Y., Lo, A., Kong, W., Ng, L. C., & Cook, A. R. (2016). Three-Month Real-Time Dengue Forecast Models: An Early Warning System for Outbreak Alerts and Policy Decision Support in Singapore. *Environmental Health Perspectives*, 124(9), 1369-1375. <https://doi.org/10.1289/ehp.1509981>

and management by offering real-time data collection and analysis through connected sensors that monitor environmental conditions, infrastructure status, and community needs. During crises, IoT facilitates improved coordination among emergency response teams, supports efficient resource allocation, and ensures continuous communication. Moreover, post-disaster, IoT aids in assessing damage and streamlining recovery efforts, thus fostering resilience and preparedness for future disasters.

A1.1.4 National mobile warning system in Türkiye¹²⁰

Necessity of public warning systems

In situations where emergencies pose a threat to public order, national security, and cybersecurity, it is of vital importance to make necessary announcements to the public and to disseminate warnings and guidance to large audiences as quickly as possible. To achieve this objective, it is commonly preferred for relevant public institutions to communicate the required notifications, within geographically defined areas to individuals through their mobile devices, in accordance with the tasks and responsibilities assigned to them. The public warning systems utilized within this context are systems that enable the authorities to alert the public about inevitable or ongoing emergencies and disasters.

National mobile warning system in Türkiye

The Information and Communication Technologies Authority (BTK) in Türkiye, issued a regulation on 26 February 2021, concerning the establishment and operation of a National Mobile Warning System tailored to the needs of the country. The development and implementation of the system is based on compliance with technical specifications prepared by the European Telecommunications Standards Institute (ETSI), and takes advantage of the best opportunities offered by modern technology. The National Mobile Warning System incorporates the cellular broadcast service (CBS) as one of its primary technologies in accordance with the guidelines specified in ETSI TS 123.041. With CBS, it becomes possible to reach all users with devices supporting CBS technology in a specific region. Moreover, CBS does not burden the base stations excessively, resulting in less congestion during disaster and emergency communications.

Additionally, the technical specifications for the mobile alarm system, known as the Commercial Mobile Alarm System (CMAS), have been determined according to the country's needs by adapting the guidelines provided in ETSI TS 122.268. The system will also be able to reach target audiences through short message service (SMS) texts, and pre-call announcements. The technical infrastructure of the National Mobile Warning System has been entirely developed using domestic resources, and the use of domestic resources in the systems developed, and the infrastructure established by operators is encouraged. Critical public institutions, including the Presidency of the Republic of Türkiye, the Disaster and Emergency Management Authority (AFAD), and BTK utilize this system within their mandate in accordance with the respective law. This ensures rapid and effective dissemination of information to citizens in circumstances of necessity.

Implementation of the system

Türkiye uses the National Mobile Warning System to warn citizens to take necessary precautions in advance of hazards. This is especially the case concerning floods which are more predictable, and hence suitable for early warnings. However, in situations such as earthquakes which are more sudden and unpredictable, the system can be used for crisis management tasks such as dissemination of information about the gathering zones, humanitarian aid locations, or locations of people in need. Türkiye conducts drills using the system regularly. Such a drill was held in Türkiye on the anniversary of the Düzce Earthquake of 12 November 1999. With the warning sent from the AFAD Centre via the

¹²⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0243/> from Türkiye.

National Mobile Warning System, a "Drop, cover and hold-on" exercise was performed throughout the country.

On 27 June 2023, a CMAS message was sent to warn the people about the risk of flooding in specific districts of the Zonguldak, Bartın, and Kastamonu provinces. The message read: Due to the heavy rainfall in your region, which will increase its effect starting from this evening and will continue through tomorrow, it is important to be cautious to stay away from stream beds, flood plains, and risky areas. In case of emergency, it is strongly recommended to call 112 Emergency Call Centre.

Potential use cases

- **Natural disasters:** The system can be used to alert citizens about imminent natural disasters such as earthquakes, tsunamis, floods, hurricanes, or wildfires. The system can provide timely warnings and safety instructions to people in the affected areas, allowing them to take necessary precautions and evacuate if needed.
- **Public safety emergencies:** In cases of public safety emergencies such as terrorist threats, active shooters, or chemical spills, the system can quickly inform the public about the situation, and provide guidance on how to stay safe and avoid the affected areas.
- **Severe weather warnings:** The system can issue alerts for severe weather conditions such as heavy storms, tornadoes, blizzards, or extreme heat waves. This way, people can be prepared for potential hazards and protect themselves accordingly.
- **Public health alerts:** During disease outbreaks or health emergencies, the system can be utilized to disseminate vital information about preventive measures, vaccination campaigns, and updates from health authorities to ensure public safety and containment.
- **Amber alerts:** The system can be used for 'amber alerts', which are issued in cases of child abductions. By sending out notifications to a wide audience, the system can increase the chances of finding missing children and apprehending abductors.
- **Infrastructure failures:** In the event of significant infrastructure failures such as major road closures, power outages, or water supply disruptions, the system can inform affected residents, and provide alternative routes or solutions.
- **Evacuation notices:** The system can efficiently communicate evacuation orders in situations where people need to leave their homes due to imminent threats such as a hazardous materials spill, or nuclear plant malfunction.

These use cases demonstrate how National Mobile Warning Systems can play a crucial role in ensuring public safety, quick response, and efficient communication during various emergencies and critical situations.

A1.1.5 Telecommunications/ICTs for disaster risk reduction and management (Bhutan)¹²¹

Bhutan faces a variety of natural disaster risks, including earthquakes, glacial lake outburst floods (GLOF), flash floods, forest fires, and landslides, which have previously resulted in substantial loss

¹²¹ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0172/> from Bhutan.

of life, property damage, and destruction of public infrastructure. Geographically situated in the Himalayan mountains region, Bhutan is recognized as one of the most seismically active regions in the world. The mountainous landscape of Bhutan has created remote and isolated settlements, that may become unreachable during major hazards and emergencies. Additionally, the absence of emergency communication facilities and protocols, along with the fragile road network and transportation system, exacerbates this vulnerability.

The telecommunications and information communications and technology (ICT) sector plays a number of crucial roles in disaster risk reduction and management, by enabling effective communication, coordination, EWSs, and response mechanisms. The Royal Government of Bhutan (RGoB) recognizes the importance of establishing a robust fibre-optic network infrastructure with redundancy links within the country, of having multiple international Internet gateways, and of establishing disaster communications networks to be utilized during times of disaster for emergency communications. In addition, in order to improve service delivery and efficiency through effective use of ICT, it was recognized that all government systems that contained highly sensitive data, would require a resilient and robust data centre to ensure security and protection. Consequently, the Government Data Centre was established. However, there is no mechanism in place to ensure the continuity of business in the event of catastrophic disasters such as earthquakes, forest fires, cyber incidents, or other major natural incidents. Therefore, the establishment of active-active disaster recovery (DR) agency is being planned in the country's 13th five-year plan to ensure continuous uptime and maintain mission-critical operations in case of a disaster.

Some of the following technologies could also be explored and implemented by leveraging telecommunications and ICTs for disaster risk reduction and management (DRRM) in Bhutan.

- Climate monitoring and s EWS: Implementing robust climate monitoring and EWSs using ICTs to help alert communities about impending disasters such as earthquakes, flash floods, and GLOFs. This could include SMS alerts, mobile apps, sirens, and radio broadcasts tailored to reach remote and vulnerable populations.
- Remote sensing and geographic information system (GIS) mapping: Utilizing remote sensing technologies and GIS mapping to aid in identifying high-risk areas prone to landslides, floods, and forest fires. This data can inform land use planning, infrastructure development, and disaster preparedness efforts.
- Communication and coordination: Establishing reliable communication networks, including mobile and satellite communication systems, for facilitating coordination among emergency responders, government agencies, and communities during disaster response and recovery operations.
- Disaster recovery and reconstruction: ICTs can support post-disaster recovery and reconstruction efforts by facilitating access to financial assistance, healthcare services, and livelihood support programmes for affected communities.

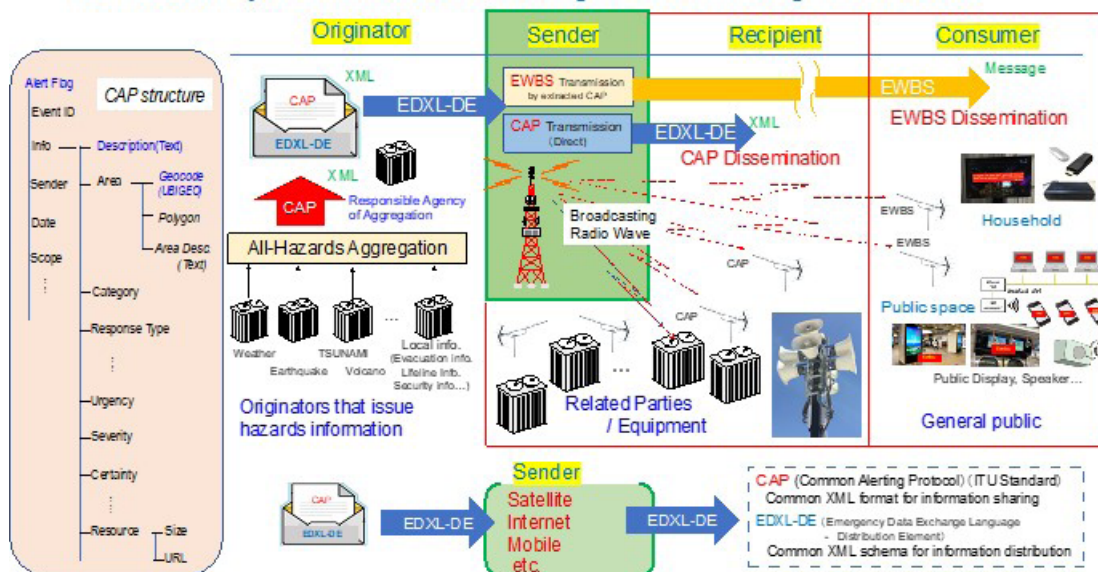
A1.1.6 Emergency warning broadcasting system (EWBS) (Japan)¹²²

In recent years, the number of natural disasters has increased in various countries due to the effects of global warming worldwide, and some of the reports by the World Meteorological Organization (WMO) show that the number of weather-related natural disasters has increased 50 times in the last 50 years. Due to the fragility of social infrastructures especially in developing countries, even a single natural

¹²² ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0080/> from Japan.

The emergency warning broadcasting system (EWBS) ensures reliable and secure one-way communication, and is a function of the disaster-information notice of the digital terrestrial broadcasting system (ISDB-T). EWBS is very highly regarded, especially in the Latin America region due to the advantages of EWBS over other systems, and especially because the terrestrial broadcasting radio wave is robust, reliable, and the system can be introduced quickly at an optimized cost. However, in order to fully utilize such advantages, it is essential to deal with the specific needs of each country, taking into account environmental changes and technological trends in the ICT field. For example, in Peru, there is a need to distribute disaster information in a common format through not only digital terrestrial broadcasting, but also through various other media. Taking such specific circumstances into account, Japan is developing the EWBS-CAP hybrid transmission system, as a universal ICT system for disaster management, which utilizes the existing terrestrial broadcasting radio waves from upstream to downstream, and is appropriate for international cooperation across borders between developing countries. Research activities are being conducted on the ideal implementation of the system into local societies in developing countries.

“EWBS-CAP Hybrid Transmission” utilizing the Broadcasting Radio Waves



More than 90 per cent of deaf children are born into hearing families. Unless the family learns sign language together, deaf children easily become isolated and may receive inadequate home education. However, a means for education in sign language in these cases does not exist in most of countries.

¹²³ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0153/> from Republic of Korea.

challenges of education, more than half of deaf persons have difficulty in understanding the text, which means that the most substantial information is not accessible by them.

TV has evolved through connectivity and whatever type of infrastructure the TV or set-top-box is based on, most TV and set-top-boxes can now have connectivity through a cable modem, direct IP communication by ISP/IPTV, or low orbit satellite constellation. Connectivity is not provided through a terrestrial frequency under the latest specifications of digital video broadcasting (DVB) and Advanced Television Systems Committee (ATSC) standards. In the United States, about 20 per cent of households have no broadband connectivity. The Government is providing e-learning contents through a datacasting feature of its next generation terrestrial specification with the aim of reducing inequality in education.

Disaster alerting information

The Ministry of Science and ICT, operates a nationwide Emergency Disaster Alerting System. The system aggregates all disaster information and sends it to a broadcaster with CAP format* and the broadcaster will then automatically show the subtitle in text.

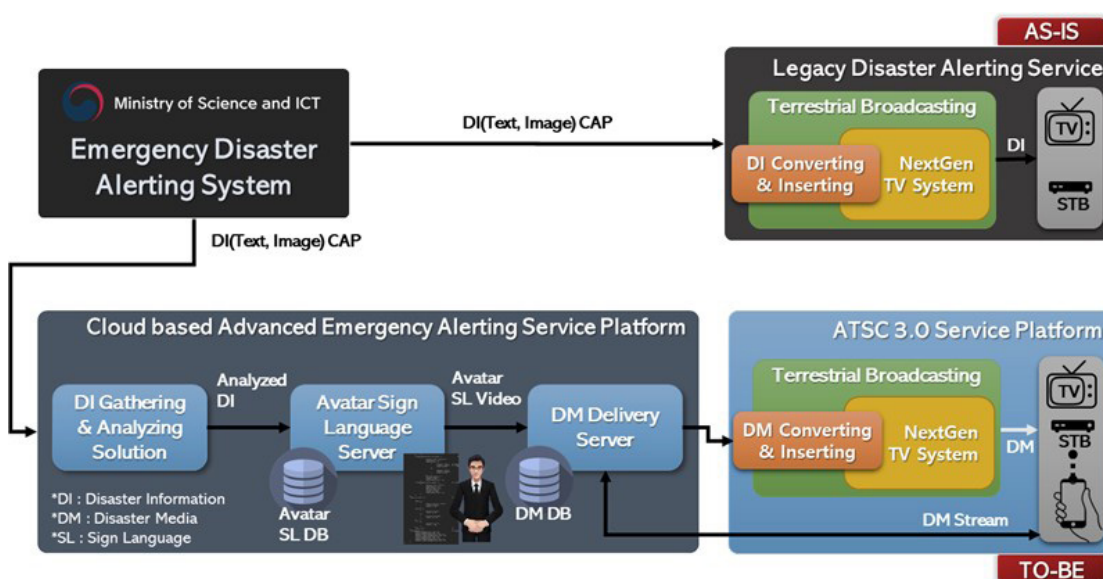
*CAP example:<identifier>KR.T7-20230416</identifier><sender>mmdip@mict</..><event>Flooding</..>..

Figure A-2: Accessible disaster alerting system with avatar sign language



As the caption (text only information) is not fully accessible a by deaf person, the consortium is developing new system based on the latest terrestrial standard specification of ATSC 3.0, where IP communication for avatar signing is possible. The project also covers pay TV, set-top-boxes, and smart phones so that a deaf person can always have access to the disaster information. Figure A-2 above shows the current system where the text and image are directly delivered to terrestrial and pushed to the STB and TV. Figure A-3 shows the new system where the disaster information is converted to disaster medias formatting including avatar signing, and then transmitted with a terrestrial signal. The DM stream can be directly streamed to mobile phones with text messages and links.

Figure A-3: Accessible disaster alerting system diagram



The system is now under development not only for the Republic of Korea public broadcaster but also for some public broadcasters in the United States where the same terrestrial specification is deployed. The pilot broadcasting was scheduled the end of 2023, at Jeju Island, Republic of Korea, with nationwide deployment in 2025. As the latest European digital terrestrial standard specification also includes IP communication, the system can be implemented in more countries.

The use case shows how the latest TV platforms can contribute to inclusive society by helping to solve very basic problems using neural sign language translation technology. This will improve the accessibility of most critical information to a deaf person. It will create the "value of safety" for a deaf person while reducing inequality in information accessibility, and so contributes to achieving SDG 10 which concerns reducing inequality. As sign language translation technology is improving in many countries, it is expected that the time will soon come when all text-or-voice-only information can be automatically translated into sign language.

A1.1.8 Use of the South Asia Satellite (SAS) network to provide national TV and radio services to rural areas (Bhutan)¹²⁴

In Bhutan, the geographical challenges of providing telecommunication and broadcasting services to rural areas have necessitated the use of innovative solutions. One such solution is the South Asia Satellite (SAS) ground station network, which has been instrumental in providing critical communication services in areas that remain unconnected by traditional infrastructure. Beyond broadcasting, the SAS network has also played a pivotal role in disaster preparedness and response, ensuring that communication systems remain operational during times of crisis.

Background and use case

The SAS ground station network is a satellite-based communication system that Bhutan has deployed to address the following key challenges:

- Broadcasting in rural areas.** Many remote areas in Bhutan have limited or no access to cable-based broadcasting services. The SAS network is used to broadcast national TV and radio channels to these regions, ensuring that rural communities receive important

¹²⁴ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0349/> from Bhutan.

information and entertainment. Recently, Bhutan have upgraded these broadcasts to high-definition (HD) quality, further ensuring that no part of the population is left behind in terms of access to high-quality content.

- b) **Disaster communication.** The SAS network also plays a vital role in the disaster communication strategy of Bhutan. During emergencies, especially in remote areas where telecommunications infrastructure may be compromised, the satellite network ensures that communication lines remain open, enabling effective coordination and response. Bhutan has established very small aperture terminals (VSATs) across the country to support emergency communication via the SAS network.

Key lessons learned

Through the implementation of the SAS network, several important lessons have been learned:

- a) **Satellite communication bridges the connectivity gap.** The SAS network has proven to be an effective solution for providing communication and broadcasting services in rural and remote areas where conventional infrastructure is not viable. This has helped Bhutan overcome the challenge of providing universal access to essential services.
- b) **Upgrading to HD broadcasting is critical for equity.** The recent upgrade to HD broadcasting services ensures that rural populations receive the same quality of information and media content as their urban counterparts. This is crucial for bridging the digital divide, and promoting inclusivity.
- c) **Dual-use infrastructure enhances resilience.** The SAS network can switch between normal broadcasting operations and emergency communication during times of crisis, which has increased the disaster resilience of Bhutan. This dual-use model ensures that resources are utilized efficiently, minimizing downtime and maximizing preparedness.

Best practices

Based on the experiences of Bhutan, the following best practices for countries considering similar satellite-based communication solutions are recommended:

- a) **Establish clear operational frameworks.** It is essential to define clear frameworks that govern the use of satellite infrastructure, specifying roles for normal operations and emergency situations. This ensures quick and efficient transitions when crises arise.
- b) **Collaborate with key stakeholders.** Close collaboration between government agencies, telecommunications service providers, and international satellite operators is critical for the smooth deployment and management of satellite networks. This collaboration also ensures that services are aligned with national disaster management strategies and ICT policies.
- c) **Invest in upgrading rural broadcasting services.** Upgrading broadcast quality in rural areas helps ensure that populations in remote regions are not left behind. Investing in HD or other advanced services promotes inclusivity and supports national objectives for digital equity.

The use of the South Asia Satellite (SAS) in Bhutan has significantly improved the nation's ability to provide critical communication services to rural and remote areas. The network dual-use functionality for both broadcasting and disaster communication highlights the versatility of satellite infrastructure in addressing multiple national challenges.

A1.1.9 Cell-broadcast (CB) alerting (Everbridge One2many)¹²⁵

Everbridge One2many, fully embraces a multi-channel approach as the global leader in both location-based-SMS solutions (in Australia, Sweden¹²⁶, Norway, Singapore, Estonia), CAP based solutions (in Kingdom of the Netherlands¹²⁷, Mauritius¹²⁸, Spain, Norway¹²⁹, Saudi Arabia) and CB based solutions (deployments in 37 mobile operators).

The experiences of location-based-SMS (LB-SMS) are valid projects, but they require longer implementation times due to their complexity, as they are not standardized. Therefore, a different integration is needed at every mobile operator, requiring integration with existing location probes at an operator or provision of new location probes in each mobile network, to deliver an additional Alert-SMSC or integrate with an existing SMSC. These projects are complex as there many different vendors active in the LB-SMS domain (at least 40-50 different vendors) and some of the integrations are done with mobile operator-specific developments, which makes it even more customized. Many vendors in the LB-SMS domain use different protocols and integrations. Finally, the LB-SMS solution for public warning is not standardized in any standardization body and therefore LB-SMS projects are complex, with longer lead times (at least 1 year), and for every deployment a customized and different approach is necessary.

CB is a simpler approach for a public warning system, and is a 3GPP, ETSI and ATIS standardized solution for public warning fully supported by the telecommunications industry, with relatively short delivery times, and less complexity as all radio access network (RAN) vendors support the CBC 3GPP standard. CB is a far more suitable technology to be implemented in the developing countries targeted by the 'Early warning for All' initiative, as it is a fully standardized, 'plain-vanilla' implementation (no surprises when implementing), fully supported by the telecommunications industry, having a similar approach for every country, and incurs much more predictable project timelines.

Useful references:

- a) 2013 GSMA PWS in DRR (2013) – <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/01/Mobile-Network-Public-Warning-Systems-and-the-Rise-of-Cell-Broadcast.pdf>
- b) 5G Americas' Recommendations on Public Warning as specified by 3GPP (2018) – <https://www.5gamericas.org/public-warning-systems-in-the-americas/>
- c) BERC Guidelines for Art.110 (2020) implementation of EU Dir. 2018/1772 (Public warning effectiveness criteria mandated for all European Union MS) – <https://www.berec.europa.eu/en/document-categories/berec/regulatory-best-practices/guidelines/berec-guidelines-on-how-to-assess-the-effectiveness-of-public-warning-systems-transmitted-by-different-means-0>

¹²⁵ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0066/> from Everbridge One2many.

¹²⁶ <https://www.krisinformation.se/en/finding-help-and-services/emergency-warning>

¹²⁷ <https://www.nl-alert.nl/>

¹²⁸ <https://ndrrmc.govmu.org/Pages/nmheas.aspx>

¹²⁹ <https://www.emergencyalert.no/about-emergency-alert/>

For the multi-channel approach, the CAP standard was proposed, as defined by OASIS, as a solution. The CAP interface can be used as the default integration for public warning with websites, Mobile apps, Radio, TV, SMS, WMO, digital boards, etc. CAP has also proven to be a simple, easy deployable standardized public warning interface in many countries, that can be very rapidly (2-3 months) used and integrated into any public warning solution. Another advantage is that CAP can also be used as the default interface to integrate between the government domain and the telecommunications company domain (CBC and LB-SMS).

<https://preparecenter.org/site/ifrcalerthubinitiative/call-to-action-on-emergency-alerting/>

<https://www.anticipation-hub.org/events/common-alerting-protocol-cap-implementation-workshop>

A1.1.10 SMART CAM submarine cable system (Portugal)¹³⁰

After first raising awareness for the issue in 2017, ANACOM has been actively engaged in ensuring the timely and future-proof construction of the new electronic communications interconnection between the mainland of Portugal and the Azores and the Madeira archipelagos (CAM), via the 'Science Monitoring And Reliable Telecommunications (SMART)' submarine cable system. The SMART acronym was coined by the 'Joint Task Force (JTF) to investigate the use of submarine telecommunications cables for ocean and climate monitoring, and disaster warning under the auspices of ITU/WMO/ UNESCO IOC'¹³¹. As shown in Figure A-4, the present CAM interconnection has been ensured using a domestic submarine cable connecting Madeira and Azores; a leg of the Columbus III cable for interconnecting Azores and mainland Portugal, and a leg of the Atlantis 2 cable for interconnecting Madeira and mainland Portugal. The Columbus III cable system entered in service in 1999, and the ATLANTIS 2 in 2000, and will reach the end of their useful lifetime by the end of 2024, and early 2025 respectively. However, the Columbus III and ATLANTIS 2 international cable systems were subject to 'early retirement' respectively in 2020, and 2021, as the international demand for capacity had been met by other systems that have been constructed more recently. The above-mentioned legs have nevertheless been maintained in service for CAM interconnection by Altice, the national operator that had co-invested in, and operated, these submarine cables.

Figure A-4: The CAM interconnection in 2019



As the national operator 'Altice' had no plans to substitute these interconnections in the CAM region, in 2019, the Government of Portugal set up a working group (CAM WG)¹³², chaired by ANACOM, with the Autonomous Governments of Azores and Madeira, as well as representatives of concerned ministries, to analyse the situation and propose a solution. At the same time, EMACOM, a regional

¹³⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0077/> from Portugal.

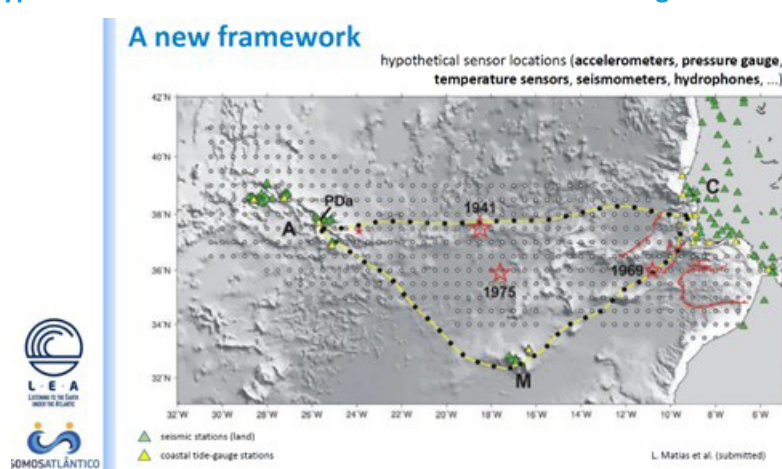
¹³¹ <https://www.itu.int/en/ITU-T/climatechange/task-force-sc/Pages/default.aspx>

¹³² Order nr. 4805/2019, May 13th; Office of the Assistant Secretary of State and Communications <https://files.dre.pt/2s/2019/05/09100000/1455814559.pdf>

public operator in Madeira, purchased capacity in a leg connecting Madeira to mainland Portugal, which is part of the 'Ellalink,' a new cable system connecting South America to Europe.

The CAM WG heard numerous stakeholders including manufacturers, operators, investors, cable systems promoters, public institutes, and universities, and by the end of 2019, delivered a final report recommending a number of prerequisites for the CAM interconnection. Among these prerequisites was the inclusion of seismic detection and climate monitoring (SMART) functionalities, which were estimated at 10 per cent of the EUR 120M total cost of the project. The Portuguese Institute for the Sea and Atmosphere (IPMA) a LEA¹³³ member, presented hypothetical locations of desired submarine sensors in the CAM region to complement existing monitoring stations, see Figure A-5. IPMA considered that a SMART CAM would complement its seismic detection and climate monitoring capabilities which were based on research vessels, autonomous vehicles, and fixed observatories, and present a disruptive and innovative approach to ocean monitoring.

Figure A-5: Hypothetical locations of desired sensors in the CAM region. Source: IPMA



JTF SMART Cables, has been advocating the adoption of SMART functionalities, which would enable real time monitoring of ocean bottom temperature and pressure, from which measures of heat content and currents can be obtained. These are needed for climate monitoring, since oceans store a large fraction of the CO₂ and the energy associated with its production. With such data, future temperatures around the globe can be more accurately predicted and used, to better address the impacts of climate change. SMART cable networks also have seismic and tsunami detection capabilities and will, therefore, provide early warnings. In September 2020, the government followed most of the CAM WG recommendations, including the inclusion of SMART functionalities, and mandated¹³⁴ Infraestruturas de Portugal, S. A., a public infrastructure operator, to manage the new CAM cable system project as a wholesale neutral operator.

In September 2021, the government granted the concession¹³⁵ to Infraestruturas de Portugal for the promotion of activities relevant to the conception, installation, maintenance, exploration, and operation of the CAM submarine cable interconnection, and the possibility of sub-concessioneering any activity. LEA (Listening to the Earth under the Atlantic), a group of public universities and institutes, assisted Infraestruturas de Portugal in procuring the seismic detection and climate monitoring functionalities for the CAM. The resulting document "Description and implementation of the 'Observer

¹³³ LEA (Listening to the Earth under the Atlantic) is a consortium with two public Institutes and one not-for-profit organization of public interest: IPMA, <https://www.ipma.pt/en/index.html>; IDL, <http://idl.campus.ciencias.ulisboa.pt/> and IT, <https://www.it.pt/>

¹³⁴ Order nr. 9333/2020, September 30th; Offices of the Assistant Secretary of State and Communications and of the Secretary of State of Infrastructures <https://files.dre.pt/2s/2020/09/191000000/0012900131.pdf>

¹³⁵ Decree-Law nr. 63/2022, September 26th. <https://dre.pt/dre/detalhe/decreto-lei/63-2022-201450532>

Part' of a SMART cable"¹³⁶ will be a key contribution to the Joint Task Force and SMART development. An earlier LEA document, "Management considerations to elaborate a Request for Tender for a SMART cable"¹³⁷ published in December 2021, also deserves attention. The public procedure for the acquisition through 'requests for proposal' for a SMART CAM cable system was launched 13 December 2022¹³⁸, and the received proposals were, at the time of writing April 2023, being analysed.

A recent study¹³⁹ measured the impact of an earthquake early warning system (EEWS) considering the current seismic network in Portugal, as well as the potential installation of submarine CAM sensors. The results indicated that for the districts located in the southwest of the country, an earthquake EWS might provide sufficient warning time for risk mitigation measures to be followed. In the case of a tsunami early warning system (TEWS) the lead time was estimated at tens of minutes. The collection and proper processing of the data provided by the seismic and tsunami detection capabilities implemented on SMART cable networks has, therefore, a huge potential for disaster risk reduction and management. In this context, a new draft ITU-T Recommendation G.smart, is being developed within the framework of ITU-T Q8/15 and that of PP22 Resolution 136 (Rev. Bucharest, 2022) on "The use of telecommunications/information and communication technologies for humanitarian assistance, and for monitoring and management in emergency and disaster situations, including health-related emergencies, for early warning, prevention, mitigation and relief". This document:

- considers "that oceanic sensing technologies, which may be deployed through, or by using undersea cables, can be used for early warning and disaster risk reduction, preparedness and response, including tsunami and earthquake early warning";
- considers further "the activities of the Joint Task Force to investigate the use of submarine telecommunication cables for ocean and climate monitoring and disaster warning (JTF SMART cable systems), established in late 2012, by ITU, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO/IOC), and the World Meteorological Organization (WMO);
- encourages Member States "to contribute actively to the development of oceanic sensing technologies, including the work of the JTF SMART cable systems";
- refers to ITU-D Resolution 34 (Rev. Kigali, 2022) on "The role of Telecommunications / information and communication technology in disaster preparedness, early warning, rescue, mitigation, relief and response";
- recognizes "that the concept of SMART (scientific monitoring and reliable telecommunication) cable includes scientific sensors mounted in the repeaters of submarine cables to measure ocean-bottom temperature, pressure and seismic acceleration";
- considers "the need to investigate the use of submarine telecommunication cables for ocean and climate monitoring and disaster warning", and

¹³⁶ <https://www.itu.int/en/ITU-T/climatechange/task-force-sc/Documents/Observer-part-SMART-cable.pdf>

¹³⁷ https://www.itu.int/en/ITU-T/climatechange/task-force-sc/Documents/LEA-contribution-to-JTF_RfT-for-a-SMART-Cable.pdf

¹³⁸ <https://www.portugal.gov.pt/pt/gc23/comunicacao/comunicado?i=esclarecimento-sobre-o-projeto-de-substituicao-do-sistema-de-cabos-submarinos-que-ligam-o-continente-aos-acores-e-madeira>

¹³⁹ "Earthquake early warning for Portugal: part 1 - Where does it matter?" in Bulletin of Earthquake Engineering, Vitor Silva, Amir Taherian and Carlos Sousa Oliveira.

- invites "BDT to consider how space-based technologies, submarine telecommunication cable networks, and associated sensor technologies can be used to help ITU Member States collect and disseminate data on the effects of climate change and support early warning, having regard to the link between climate change and natural disasters".

A1.1.11 Visual-IoT systems for disaster detection (NICT)¹⁴⁰

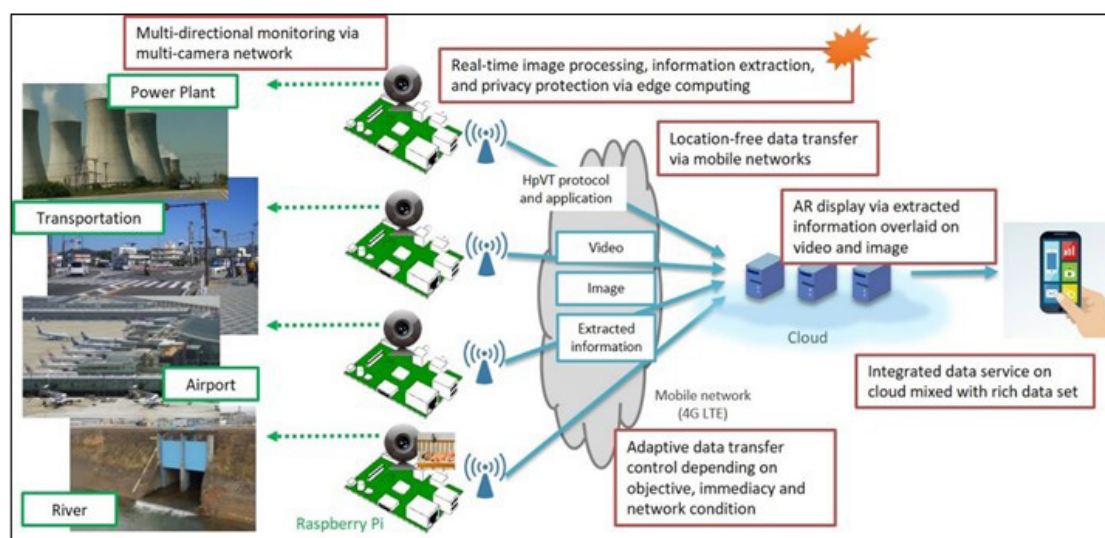
'Resilient natural environment measurement' is a concept proposed by NICT, which could be a novel technique for monitoring the environment based on a combination of broadband network and Internet of Things (IoT). One of the key issues of resilient natural environment measurement, is to monitor areas using sense of sight and sense of sound devices in association with sense of touch (legacy sensor) devices. In addition to legacy sensors, a novel technique also uses sense of sight (visual IoT) devices. As science and technology are increasingly applied to reduce uncertainty regarding environmental risks, natural environment measurement methodologies are revealing a potential for disaster risk management, primarily before, but also during and after events.

Visual IoT system for disaster detection

Visual IoT: The visual IoT concept, proposed by [Iyer et al.] in 2016, utilises image sensors or video sensors, such as closed circuit television (CCTV) cameras, as IoT sensors (Figure A-6). Visual IoT devices are deployed in society today to monitor power plants, transportation, airports, rivers, and so on. Real-time image processing and information extraction with privacy protection are required functions, and mobile networks can provide location-free data transfer. Moreover, the advanced characteristics of the visual IoT system including adaptive data transfer control depending on the objective, immediacy, and network conditions; augmented reality (AR) display via extracted information overlaid onto image and footage; and integrated data services on the cloud mixed with a rich data set such as a geographic database; all reveal something of the intelligent and multi-functional potential of visual IoT. Visual IoT systems are equipped with a video transmission device, such as an IP network camera, that is connected to the mobile network to transmit footage or images to cloud servers. Two key issues were pointed out by [Iyer et al.]: (1) problems with high-quality video transmission, and (2) information extraction from images, using image processing and image recognition techniques. To solve issue (1), NICT [Murata et al.] proposed in 2019, a new video transmission protocol, called high-performance video transmission (HpVT) protocol, to achieve high performance for monitoring a variety of outdoor phenomena over mobile networks such as 4G/LTE and 5G mobile networks, and WiFi and satellite communication networks.

¹⁴⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0088/> from Japan.

Figure A-6: Visual IoT concept

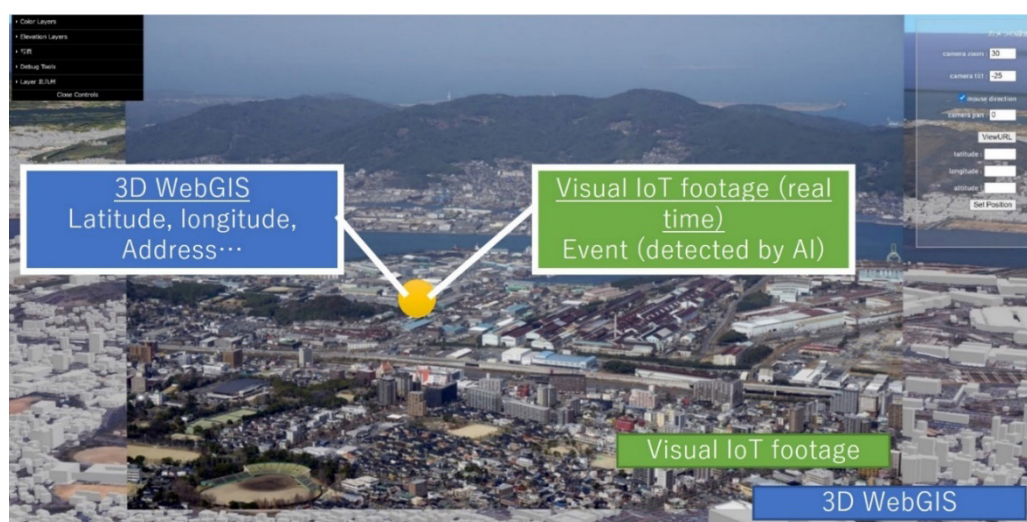


Issues for deployment: A critical issue to be overcome before the wide deployment of visual IoT systems in society can be achieved, is that of visual IoT system sensor costs. The high cost of sensors can often become a barrier to the dissemination of IoT sensors. One example is that of the water level sensors deployed by the Ministry of Land, Infrastructure, Transport and Tourism, in Japan (MLIT), where the installation costs at one site amounted to over several million USD. In order to monitor water levels for detecting river flood risks, sensors needed to be deployed every 1 km along the river. However, such a dense deployment of water level sensors on the river was difficult due to the high costs incurred. To increase the number of sensors, visual IoT systems assembled using commercial off-the-shelf (COTS) equipment could help resolve the cost issue.

Issues for disaster detection: Visual IoT systems are used to monitor fields, forestry, rivers, etc., and provide large volumes of images or footage. Information extraction of disaster events or phenomena from the images or footage, mentioned as issue (2) above, is achieved using image processing techniques. These techniques become more effective with the help of the pan-tilt-zoom (PTZ) functions of IP network cameras, which enable development of an autonomous system to detect, track, and extract disaster risk information, and to aid decision-making on required actions. To achieve disaster risk mitigation, the extracted disaster risk information from the video should be processed in real-time. Image processing techniques, especially those using artificial intelligence (AI) or machine learning (ML), need to be installed on the visual IoT system for detecting disaster events. Due to the development of single board computers equipped with a graphic processor unit (GPU) or a tensor processing unit (TPU), edge computing may be one of the options for the building visual IoT systems for disaster mitigation, that may contribute to more rapid detection of risk events.

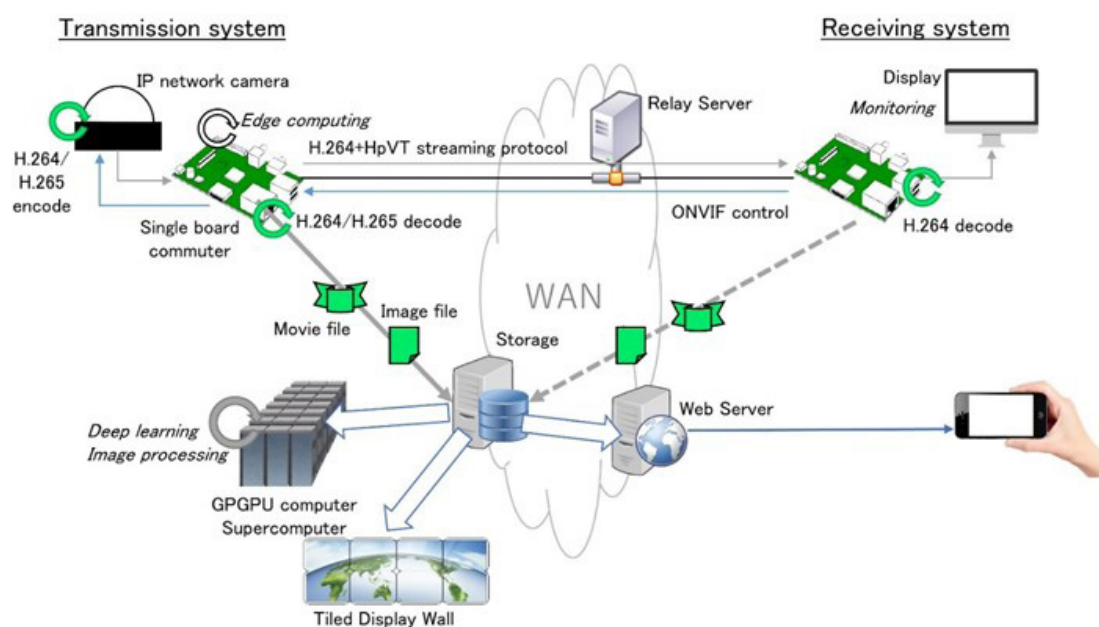
Issues for combining GIS: Considering the quick action and first responses required when a disaster occurs, a combination of geographic information system (GIS) with image processing via a visual IoT system, might shorten disaster response times. When an image processing application finds a disaster event on images or footage, it needs to identify the location of the event, as well as the scale of the disaster. Synchronization techniques of visual IoT images or footage with 3D GIS mapping have recently been developed. Figure A-7 shows an example of the synchronization; footage (inside view in the figure) by a visual IoT system at Kitakyushu city, Japan, is almost completely overlaid with a view of the 3D GIS (background view in the figure) provided by iTowns, an 3D WebGIS tool, that contains a 3D building object (PLATEAU provided by MLIT). This figure indicates that a disaster event that is detected automatically by AI from the image, is directly mapped onto the 3D WebGIS. The system can easily and quickly provide geographical information at the disaster affected area, such as the address, social facilities, traffic conditions, levels of river water, weather conditions, and so on.

Figure A-7: Overlay of visual IoT image on 3D WebGIS



Case study of a visual IoT system: NICT, Japan, developed a cost-effective visual IoT system for detecting disaster, which is also intended for easy installation. Figure A-8 shows a schematic of the visual IoT system developed for detecting disaster events. Using single board computers for edge computing units, such as Raspberry Pi (hereafter RPi) and an IP network camera with PTZ functions, NICT designed the system based on the HpVT protocol. As HpVT runs on Raspbian, which is an operating system (OS) based on generic Linux OS, edge operations are easily programmed. Combining the PTZ function and WebRTC streaming on the visual IoT system, the visual IoT system becomes an autonomous disaster detection system.

Figure A-8: Visual IoT system



NICT has been testing the developed visual IoT system in real situations. Real-time, or quasi real-time, transmission of images and footage using HpVT protocol has already been tested with success. Figure A-9 show an example of the detection of smoke on footage provided by the developed visual IoT system, in Chikuma city, Japan. In the figure, superposed texts indicate moving objects that are automatically detected on the footage, and the white texts indicate smoke caused by fire. The text

in black indicates moving vehicles. The latency to event detection is less than few seconds, which provides enough time to make quick decisions and formulate a response.

Figure A-9: Smoke detection via real-time image processing [Kikuta et al.]



Useful references:

[Iyer et al.] R. Iyer and E. Ozer, Visual IoT: Architectural Challenges and Opportunities; Toward a Self-Learning and Energy-Neutral IoT, IEEE Micro, vol. 36, no. 6, pp. 45-49, 2016.

[Murata et al.] K. T. Murata, P. Pavarangkoon, S. Phon-Amnuaisuk, T. Mizuhara, K. Yamamoto, K. Muranaga and T. Aoki, "A Programming Environment for Visual IoT on Raspberry Pi," in The 5th IEEE International Conference on Cloud and Big Data Computing (CBDDCom 2019), Fukuoka, Japan, Aug. 5-8, pp. 987-992, 2019, doi: 10.1109/DASC/PiCom/CBDDCom/CyberSciTech.2019.00180.

[Kikuta et al.] A smoke detection method based on variances of optical flow and characteristics of HSV color, submitted to IEEE Transactions on Industrial Informatics, 2023.

A1.1.12 Earth observation: role, prediction and relief in India¹⁴¹

As India is surrounded by the Arabian Sea in the west, the Bay of Bengal in the east, and the Indian Ocean in the far south, the country has always suffered from inundations due to tropical cyclones originating over the Bay of Bengal, the Arabian Sea, and the Indian Ocean. The west coast of India is more vulnerable to tropical cyclones than the eastern coastal area, and experiences extremely severe cyclones.

Earth observation: role in climate change mitigation. Earth observation is a new frontier technology tool which is helping populations face weather challenges using satellite observation of the Earth and weather movements. The system can observe the entire Earth surface at the same time. This represents a revolution in meteorological science as satellite images are continuously collated and used to accurately forecast weather events such as rain, storms, cyclones, etc. The system is therefore used in EWSSs, and helps to mitigate the harmful effects of weather or geohazards.

Cyclone Tauktae and Earth observation: case study from India. In May 2021, the Indian Meteorological Department (IMD) had forecasted the formation of a cyclonic storm over the Arabian Sea. Initially,

¹⁴¹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0117/> from India.

through Earth observation satellites of the Indian Space Research Organization (ISRO) and NASA satellites, what was to develop into a cyclone appeared to be just a low-pressure area over the Arabian Sea. Tauktae developed into a full cyclonic storm with wind speeds of up to 87 km/h, and reached the Odisha-West Bengal Coast within six days. Cyclone Tauktae continued to develop into an extremely severe cyclonic storm (ESCS) with wind speeds of up to 185 km/h, and caused severe damage in a number of states on the coast of India including Goa, Karnataka, Gujarat, and Maharashtra. All of these states experienced massive damage to property, with electrical supply and infrastructural damage. The cyclone caused extreme winds, high rainfall, and massive storm surges. Even the city of Mumbai faced the impact of the cyclone. A few hours ahead of cyclone Tauktae hitting the Porbandar and Mahuva coasts, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) Suomi National Polar-orbiting Partnership (NPP) satellites, through a visible infrared imaging radiometer suite (VIIRS) had predicted the storm using colour imaging. The United States Joint Typhoon Warning Centre also predicted extreme wind velocity from 125 miles per hour to 145 miles per hour, and declared it to be a category 3 or 4 hurricane. Though cyclone Tauktae caused great damage to trees, power, telecommunications infrastructure, and rail lines, etc., due to timely prediction, the Government had time to launch alerts for citizens through various ICT means, such as repeated radio and television announcements, bulk messages directly to mobile phones by all telecommunication operators, telephone reminder messages, etc. Coastal areas and mariners at were evacuated, and people were conveyed to shelters. These measures helped greatly in reducing mortalities, even though due to the cyclone intensity a lot of damage was done to trees, crops, and infrastructure. Due to timely alerts through Earth observation, quick response, and preparedness, many lives were saved.

Role of the Department of Telecommunications and the telecommunications/ICT sector in cyclone relief and mitigation. The Department of Telecommunications (DoT) ensured that in the states affected by cyclone Tauktae, telecommunication services remained uninterrupted. Telecommunications infrastructure providers assured the Government of India that sufficient alternate energy sources such as batteries, battery banks, spare parts for repairs, and diesel should be stocked in order to overcome power cuts and keep the telecommunications towers running. Restoration teams were kept on high alert. The Department, the Cellular Operators Association of India (CAOI) and the Digital Infrastructure Providers Association (DIPA) initiated roaming between circles, so that in case any service provider had lost of infrastructure, citizens would not face any communications problems. Extra cell on wheels (CoWs) were also kept as standby. All the major stakeholders including Bharti Airtel and Jio, along with Vodafone, Idea, and the state-run public sector undertaking (PSU) Bharat Sanchar Nigam Limited (BSNL), cooperated with the DoT to come together to help the affected states, and ensure there was no disruption of telecommunication services. Focused war rooms were set up by telecommunications operators to maintain infrastructure and focus on restoration work, and so avoid any kind of service disruption.

Way forward: In India, NASA and the Indian Space Research Organization (ISRO) have collaborated to develop an observatory for Earth observation employing a system of satellites. These satellites will work towards providing a 3D holistic view of the Earth. The aim of this collaboration is better climate change and disaster mitigation, prediction of fire hazards, accurate weather prediction for agriculture through Earth observation, etc. This advanced Earth observation system, which utilises ISRO radars, will further provide information to fight climate change and help in disaster mitigation efforts. ISRO has been at the forefront of Earth observation efforts in India. ISRO has launched several satellites, including the Indian National Satellite System (INSAT) series, and the Oceansat series, which are dedicated to Earth observation. These satellites provide critical data on weather patterns, atmospheric conditions, and oceanography enabling authorities to effectively monitor and manage natural disasters such as cyclones. In addition to ISRO, several other organizations and institutions are working towards the effective management of cyclones in India. The National Disaster Management Authority (NDMA) is responsible for coordinating efforts to manage natural disasters in India. The Indian Meteorological Department (IMD) provides weather forecasting services, and issues warnings for natural disasters, including cyclones.

In addition to monitoring and predicting cyclones, Earth observation can also aid in post-cyclone recovery efforts. It can provide information on the extent of damage caused by a cyclone or other events, enabling authorities to prioritise relief efforts, and allocate resources effectively. Earth observation data can also help to identify areas that are at risk of flooding or landslides, enabling authorities to take necessary measures to prevent such occurrences.

Sources

- <https://www.indiatoday.in/amp/science/story/nasa-isro-disaster-management-system-climate-change-cyclone-1806655-2021-05-25>
- https://m.economictimes.com/industry/telecom/telecom-news/cyclone-tauktae-dot-reviews-telecom-infrastructure/amp_articleshow/82663626.cms
- https://m.economictimes.com/industry/telecom/telecom-news/telcos-working-with-dot-infra-firms-to-mitigate-impact-of-cyclone-tauktae/amp_articleshow/82736920.cms

A1.1.13 Application of fibre-optic sensing technology in pipeline risk awareness and warning (China)¹⁴²

Petroleum is one of the most important economic resources in the world today. However, uneven geographical distribution, and the physical properties of petroleum mean that transporting the resource to where it is needed presents a tough challenge. Oil and gas are typically transported by rail, road, water, air, or pipelines. Of these, pipelines are the least restrictive and most suitable transportation method for oil and gas products. According to statistics, 50 per cent of the world's oil and gas pipelines have been operating for more than 30 years, and oil and gas pipelines are facing serious operational safety issues. There are many reasons for pipeline failure, including external force, corrosion, and material and construction defects. According to statistics from the National Energy Administration of China, by the first half of 2021, China's oil and gas pipelines had exceeded 175 000 kilometres. In the past two decades, the number of accidents caused by leakage, accounted for a large proportion of the accident rate. In addition to soil pollution, serious leakage accidents can cause explosions, which poses a serious threat to the productivity and lives of the surrounding people. Therefore, more and more attention has been paid to the development of intelligent detection and location technology for pipeline leakage.

Figure A-10: Heavy losses and the difficulty of prevention, represent huge challenges for the safe operation of oil and gas pipelines



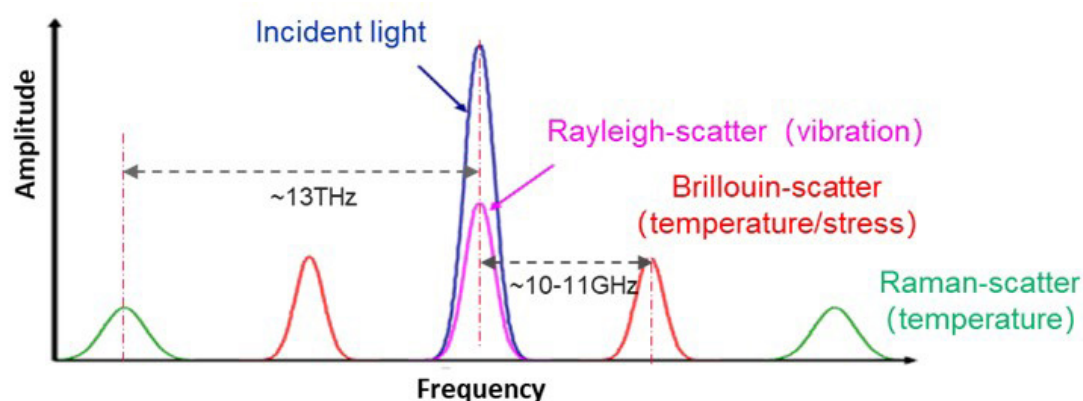
¹⁴² ITU-D Document <https://www.itu.int/md/D22-SG01-C-0216/> from China.

Solution

Current status of oil and gas pipeline risk awareness and warning: A number of digital technologies, such as sensor technologies, have already been applied to pipeline inspections. However, problems remain such as those caused by false negatives where damage goes undetected, damage is detected where there is none, or misidentification occurs where construction is mistakenly categorized. Some technologies, such as aerial drones used for inspecting power grids, are ill-suited to oil and gas pipeline scenarios, because most pipelines are built underground. Therefore, oil and gas pipeline risk awareness and warning, urgently need an automatic remote risk awareness product with high precision identification capability, and easy deployment. Leading optical technologies have been applied to the fibre-optic sensing field and a fibre-optic sensing risk awareness and warning solution has been developed. This solution comprises industry-leading identification accuracy, and can be widely used in oil and gas pipeline risk awareness and warning scenarios. Advantages of this solution include comprehensive acquisition, accurate recognition, and fast learning.

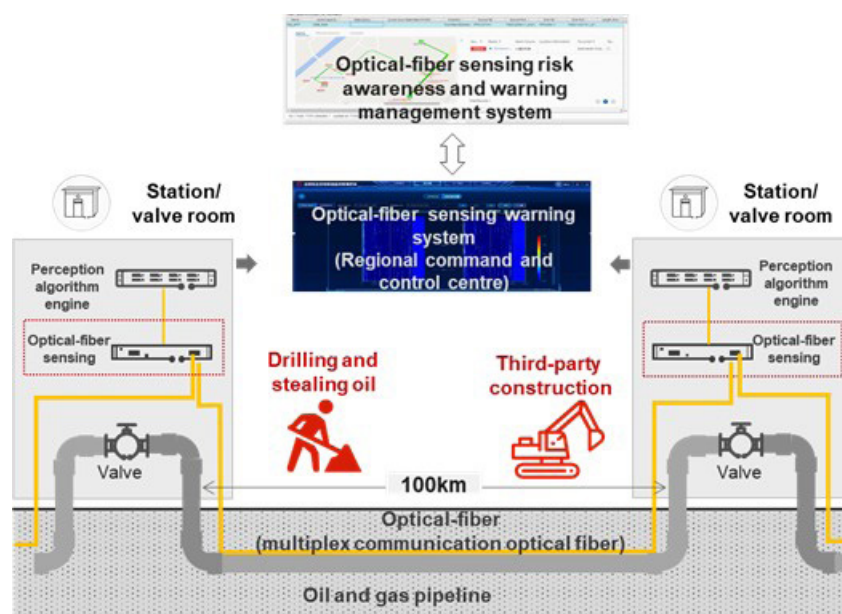
Technical principle of distributed fibre-optic sensing. Scattering occurs when light travels through optical-fibre. Fibre-optic sensing technology mainly uses Rayleigh-scatter, Brillouin-scatter, and Raman-scatter techniques. When vibration (Rayleigh-scatter), temperature changes (Brillouin-scatter and Raman-scatter), and stress changes (Brillouin-scatter) occur, the scattered signal of light changes synchronously. Each point on optical-fibre can be used as a sensing unit to be register environment changes, and measure, analyse, and locate physical parameters (vibration, stress, and temperature) around the optical-fibre.

Figure A-11: Rayleigh-scatter, Brillouin-scatter, and Raman-scatter



Fibre-optic sensing risk awareness and warning solution: Fibre-optic sensing devices are based on traditional communication optical fibre and use Rayleigh-scatter technology to detect vibration. The fibre-optic sensing device transmits pulse light to the detection optical-fibre, and collects backscattered signals returned by the optical-fibre. The collected data can form the intensity and phase baseline of scattered light at each point on the optical-fibre. When vibration occurs at any point along the optical-fibre, the intensity and phase of the backscattered light transmitted back to the fibre-optic sensing equipment change synchronously. Through the perception algorithm engine, these signals are modelled with multi-dimensional information by an intelligent recognition algorithm, and model recognition is carried out according to the model library, so that the event type and location can be accurately identified. The generated alarm information can be transmitted to the fibre-optic sensing and warning system, of the regional command and control centre, which is managed by the fibre-optic sensing risk awareness and warning management system.

Figure A-12: Fibre-optic sensing risk awareness and warning solution



Advantages of the fibre-optic sensing risk awareness and warning solution:

Signal collection: The enhanced optical digital signal processing (oDSP) module has a strong, built in correction algorithm for blind spots, which can correct and shape the phase of weak signals and raise the effective signal acquisition rate to 99.9 per cent.

Accurate identification of incidents: The exclusive vibration ripple identification engine can analyse construction incidents across multiple dimensions. For each construction vibration point, a minimum of 32 pieces of phase information are collected. Multiple features can be extracted, including voiceprint, frequency, space, time sequence, and duration. Samples are identified and compared through multi-dimensional deep convolution, raising incident identification accuracy to 97 per cent.

Fast learning: The fibre-optic sensing risk awareness and warning solution can perform iterations based on new construction behaviour data, and various geological environment scenarios in the database. Working with universities that provide large amounts of geological data, (up to 1 000 new incident samples each day) this data can be used to improve the sensing and warning accuracy of the solution.

Application cases. Shandong Jihua Gas was one of the first companies to adopt the fibre-optic sensing risk awareness and warning solution. The company operates gas pipeline networks at various levels, comprising more than 3 000 km of pipeline that supplies gas to 920 000 households and more than 3 000 industrial, boiler, and public welfare users in Jinan city.

China have worked with Shandong Jihua Gas, to deploy a 20-km underground pipeline that traverses complex environments including suburbs, national highways, and rural areas. Construction samples from excavators, rammers, ditchers, and manual excavations were collected onsite for training and model creation. Based on these, 56 tests were conducted on different road segments. The initial phase of technical verification has been completed, proving the efficacy of the intelligent optical sensing product. Shandong Jihua Gas used intelligent optical sensing products and video management systems to build an optical-visual linkage solution, improve the awareness accuracy of the oil and gas pipeline network, and reduce costs. Fibre-optic vibration is used to complete the first round of risk awareness. When an exception is detected, nearby cameras are automatically triggered to obtain onsite video information for secondary confirmation. After confirming that the exception is true, alarms are generated, and personnel are automatically arranged to attend the site and rectify any faults and risks.

Future study. China plans to develop additional optical technologies, such as the distributed fibre-optic sensing of vibration, temperature, stress, and water quality for many more industries, including the electrical power, transportation, government, and sanitation sectors. In conjunction with big data and GIS mapping, these technologies will support differentiated, multi-dimensional, and intelligent detection and warning solutions.

A1.1.14 L-Alert in Japan (Japan)¹⁴³

In areas with weak social infrastructure, even a single natural disaster can cause serious social and human damage, and it is extremely important to minimize such damage. At the same time, given the current situation of large-scale natural disasters occurring across borders, disaster risk reduction is a very important issue that should be addressed through international cooperation.

L-Alert system: Japan introduced the L-Alert system, a type of disaster prevention ICT, over 10 years ago. When local government offices and other information providers send evacuation orders, and other disaster-related information to the L-Alert system, the information is automatically distributed simultaneously to various media outlets through L-Alert, which is operated by the Foundation for MultiMedia Communications (FMMC).¹⁴⁴

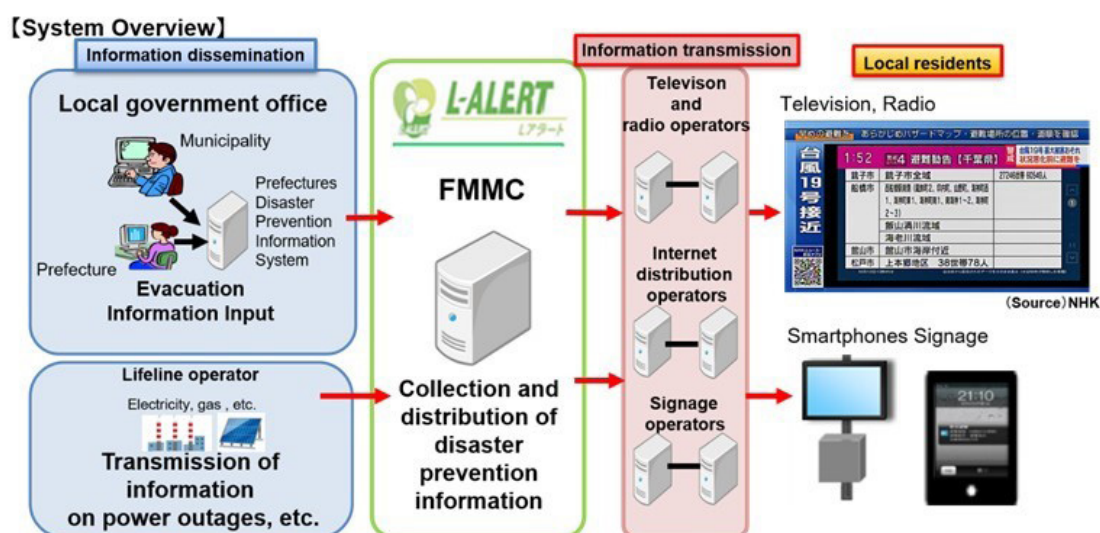
This makes it possible for all local residents, regardless of their disability or age, to reliably and quickly obtain emergency information on disasters, in an easy-to-understand 'anytime, anywhere' format through a wide range of media, including television, radio, mobile phones, and the Internet. The system has great benefits not only for local residents, but also for information providers. Only by inputting the L-Alert, it is possible to reliably and quickly transmit information to various media, etc., and by reducing the burden of transmitting information such as through individual input work, it is possible to concentrate on other essential tasks. In addition, information transmitters such as TV stations can automatically obtain wide-area and detailed disaster information in a list as electronic data. This has the advantage of being able to efficiently and effectively provide information tailored to local circumstances. In Japan, it is possible to provide information for an L-Alert in all prefectures. More than 900 registered organizations, including TV stations, radio broadcasters, websites, and disaster prevention apps, transmit information to local residents.

When a typhoon struck in September 2022, over 1 000 items of information (evacuation information, shelter information, blackout information, etc.) were provided from 137 organizations over a four-day period. Disaster-prevention ICT technologies will also be deployed in the Republic of Indonesia, a country that faces similar disaster hazards to those of Japan. The development of a system for processing and transmission of disaster prevention information, utilizing the expertise of L-Alert will lead to an increase in the number of disaster prevention information transmission destinations, to disaster prevention administrative agencies and telecommunications carriers, an increase in transmission data capacity, a reduction in transmission time, and a reduction in congestion, leading to a reduction in the risk to human life due to earthquake and tsunami disasters.

¹⁴³ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0188/> from Japan.

¹⁴⁴ See the figure below for an overview of the system <https://www.fmmc.or.jp/english>.

Figure A-13: System overview of L-Alert system



Conclusion: L-Alert, a representative of disaster prevention systems, has been successfully introduced in Japan. Ensuring that disaster-related information can be distributed reliably and quickly is an urgent issue common to all countries. Japan, which as a country has had experience with a number of disasters, can be expected to contribute to the SDGs by strengthening efforts against natural disasters, and providing the technology, and disaster prevention ICT know-how that it has cultivated over time, to countries that are also fighting against disaster hazards.

A1.1.15 Satellites for use in disaster mitigation, response, and recovery (GSOA, Access Partnership, Viasat, Turksat, SES, Japan)

Effective disaster response relies on coordination and communication. Satellites bring essential connectivity to disaster responders when other communications options are incapacitated¹⁴⁵. This is particularly critical in the first 48 hours, the most crucial timeframe after a disaster for managing relief efforts, and ensuring the safety of affected populations. When terrestrial networks are affected, satellite communications provide essential connectivity for public officials, responders, and communities to share information and coordinate efforts. This connectivity ensures that even those without access to other communication channels can stay informed and connected with their loved ones, and with authorities. Beyond the immediate aftermath, satellite communications are instrumental in continuing recovery efforts, by maintaining open communication lines throughout the rebuilding process. They enhance all phases of disaster management including disaster mitigation, preparedness, response, and recovery. Satellite data that is conveyed in real-time helps identify high-risk areas and monitor environmental changes, while satellite connectivity facilitates quick and accurate communication among emergency services, ensuring efficient relief efforts and real-time updates.

The number of recorded natural disasters has more than doubled between the periods 1980-1984 and 2015-2019, a trend likely to continue in the next decade.¹⁴⁶ Over the past 60 years, satellite communications have contributed to disaster response efforts, providing critical connectivity when terrestrial networks fail. However, these contributions were provided by overcoming many technological and administrative barriers, such as difficulties in the importation of the satellite terminal equipment to the disaster-hit area, training of personnel, interoperability of different devices and networks, or limited spectrum resources. Today, changing satellite communication technologies promise to open a new chapter in disaster communications where more robust and well-integrated systems might

¹⁴⁵ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0110/> from GSOA.

¹⁴⁶ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0103/> from Access Partnership.

provide safer and faster connectivity for disaster responders. Such a shift in connectivity during response and recovery periods after a disaster can exponentially increase the number of saved lives.¹⁴⁷

Recent advances in satellite communications have focused on the significant potential of new space-based connectivity technologies to transform disaster response and recovery. Medium Earth orbit (MEO) and low Earth orbit (LEO) constellations that offer enhanced speeds and reduced latency, allow for more efficient and reliable communication during emergencies, and ensure that first responders and coordination centres can exchange real-time information seamlessly. This technology enables the provision of better connectivity for responders, as well as communications for everyone through unified networks. Satellite technology is also employed in disaster prediction and in EWSs allowing measures to be taken in time as well as infrastructure assessments to be carried out before and after a disaster. Satellites that provide real-time data and imagery of earth, that can be used to predict and monitor disasters¹⁴⁸ might help to save lives and goods to a very significant extent. In 2022, the United Nations launched an ambitious international initiative called 'Early Warning for All'¹⁴⁹ with the goal of achieving comprehensive global EWS coverage by 2027. This initiative underscores the importance of a people-centred approach to disaster management, ensuring that communities are at the heart of all efforts. The initiative is structured around four key pillars:

Disaster risk knowledge: This involves understanding the various risks that different regions face, including natural disasters such as earthquakes, floods, and hurricanes. By gathering and analysing data, communities can better prepare for potential threats.

Observation and monitoring: Continuous monitoring of environmental conditions is crucial. This includes using advanced technologies such as satellite imagery and remote sensing to track weather patterns and other indicators of impending disasters.

Warning dissemination and communication: Effective communication channels are vital for disseminating warnings to the public. This pillar focuses on ensuring that alerts reach people in a timely manner, utilizing various platforms including mobile networks, social media, and traditional media outlets.

Preparedness and response capabilities: Building the capacity of communities to respond to disasters is essential. This includes training, drills, and the development of emergency response plans to ensure that people know what to do when a disaster strikes.

A connectivity revolution in disaster management could significantly reduce losses globally by up to USD 148 billion in 2025-2029.¹⁵⁰

As discussed in the previous section, device-to-device (D2D) satellite communications eliminate the need for bulky satellite terminals, which offers a more efficient and accessible solution for disaster response and recovery. D2D simplifies logistics, reduces costs, and speeds up the deployment of communication networks in disaster-stricken areas. Hybrid constellations have also significantly enhanced disaster communications. By integrating different satellite orbits, hybrid constellations enable real-time data exchange and continuous monitoring, which are crucial for effective disaster response and recovery. This technology ensures that first responders and coordination centres can communicate efficiently, even in remote or underserved areas.

Internet of Things (IoT) can power a resilient network of sensors to provide real-time data and situational awareness after a disaster. Sensors can be deployed on main transportation roads, bridges, and on other critical infrastructure to gather immediate information about the extent of damage during a disaster. These sensors monitor structural integrity, traffic flow, and environmental conditions,

¹⁴⁷ [Presentation](#) from Viasat at the [Transformative Connectivity Satellite Workshop](#).

¹⁴⁸ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0110/> from GSOA.

¹⁴⁹ [Presentation](#) from BDT, ITU at the [Transformative Connectivity Satellite Workshop](#).

¹⁵⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0103/> from Access Partnership.

transmitting data directly to crisis centres via satellite. This capability allows crisis centres to obtain a comprehensive picture of the damage within minutes, enabling quicker and more informed decision-making. Instead of relying on manual assessments, which can be time-consuming and dangerous, satellite-enabled IoT provides accurate, real-time insights. This technology enhances the efficiency of emergency response, and ensures that resources are allocated effectively, ultimately saving lives and reducing the impact of disasters.

Regulators and policymakers should ensure meeting the spectrum requirements in a harmonized way so that seamless communication can be provided without interference. The February 2023, earthquake disaster in Türkiye highlighted the importance of such harmonization. Turksat's swift response in re-establishing communication networks was made possible through the central coordination and support of regulators and policymakers.¹⁵¹

Examples of restoring communications networks and reconnecting after service disruptions

Kingdom of Tonga connectivity restoration in 2022 and 2019: In Tonga the urgency for connectivity reached a peak in January 2022, when the catastrophic eruption of the Hunga Tonga-Ha'apai volcano, was followed by a tsunami. The damage was profound, severing the Tonga cable system and cutting off international calls. However, SES stepped in, utilizing their geostationary Earth orbit (GEO) satellite technology to restore international calls, bringing a vital lifeline to the isolated nation amidst chaos. This was not the first time Tonga faced such challenges, as in January 2019, connectivity issues arose when the Tonga cable system was cut in two places. SES demonstrated its commitment to restoring communication in times of crisis, and ensured that the people of Tonga could connect with the outside world.

Papua New Guinea earthquakes and cable cut: In May 2019, a powerful 7.2 magnitude earthquake struck Papua New Guinea, causing significant damage to essential terrestrial and subsea infrastructure. This left many areas without connectivity, but SES quickly responded by deploying their O3b medium Earth orbit (MEO) beam. This strategic move provided an additional 1.5 Gbit/s of low-latency IP transit service, alleviating network congestion, and allowing vital communication to resume. As if nature had not already tested their resilience, a further earthquake shook Papua New Guinea in September 2022. Understanding the urgency of the situation, SES and its partners rapidly increased the O3b MEO capacity to support disaster recovery efforts, reinforcing their commitment to ensuring that even in the face of adversity, connectivity would not be lost. Through these efforts, SES not only restored communication, but also helped communities stay connected during their most challenging moments.¹⁵²

Noto Peninsula, Japan earthquake¹⁵³: At 4:10 p.m. on 1 January 2024, a powerful earthquake struck the Noto Peninsula in Ishikawa Prefecture, Japan, registering a maximum intensity of seven on the Japanese seismic scale. The quake and subsequent tsunami caused significant destruction, resulting in 241 confirmed deaths, 12 missing, and nearly 1 300 injured across eight prefectures, making it the deadliest earthquake in Japan since 2016. In response, KDDI partnered with local government and agencies, including the Self-Defence Forces, to prioritize evacuation centre support, and restore communication networks. Mobile base stations and satellite antennas were installed, providing free Wi-Fi at evacuation centres and facilitating online classes in schools serving as shelters.

¹⁵¹ [Presentation](#) from Turksat at the [Transformative Connectivity Satellite Workshop](#).

¹⁵² [Presentation](#) from SES at the [Transformative Connectivity Satellite Workshop](#).

¹⁵³ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0192/> from Japan.

A1.1.16 Harnessing real-time monitoring and ICT-driven early warning systems for strengthening disaster preparedness and response (RIFEN)¹⁵⁴

Considering the increasing frequency, complexity, and magnitude of both natural and human-induced disasters worldwide which pose significant threats to human lives, infrastructure, and economic stability, it is imperative to integrate ICTs into national and regional disaster risk reduction frameworks. Real-time monitoring systems and EWS have a transformative potential in hazard forecasting, rapid information dissemination, emergency coordination, and community empowerment through inclusive and timely communication.

Real-time tools such as IoT sensors, satellite imagery, remote sensing technologies, and unmanned aerial vehicles (UAVs) facilitate continuous environmental data collection and predictive analytics. These technologies significantly enhance situational awareness, and enable data-driven emergency responses. Evidence from the United Nations Office for Disaster Risk Reduction (UNDRR) suggests that countries with robust early warning infrastructure witness up to 60 per cent fewer fatalities during disasters.

Japan serves as a global benchmark in this regard. The Japan Meteorological Agency (JMA) operates a sophisticated earthquake early warning (EEW) system utilizing over 1 000 seismometers to detect seismic activity and issue alerts within seconds across multiple communication platforms including television, radio, mobile phones, and sirens. Tsunami warnings are similarly issued through integrated oceanic sensors, satellite feeds, and hierarchical governance structures with clearly defined evacuation protocols. This illustrates how institutional coordination, real-time ICT infrastructure, multi-platform alert dissemination, and community awareness can significantly mitigate disaster impacts.

India has also taken proactive measures in this direction. Initiatives such as the National Disaster Management Authority (NDMA) Integrated Alert System, the CAP-based mobile alerts by the Department of Telecommunications using cell broadcast services (CBS), deployment of Doppler weather radars by the India Meteorological Department (IMD), and the use of AI for cyclone prediction models are notable examples. Additionally, the use in India of SMS/USSD-based alerts in rural areas, executed in collaboration with telecommunications service providers and state disaster management authorities, exemplifies scalable, low-cost ICT solutions aimed at bridging the last-mile communication gap.

Other countries in the region have taken similar steps. **People's Republic of Bangladesh**, for instance, leverages community radio and mobile messaging platforms to disseminate early warnings, while some countries in Africa use solar-powered early warning loudspeakers and mobile alerts to reach vulnerable, low-connectivity areas. These examples highlight how ICTs can be adapted to local contexts to improve community preparedness and disaster response.

Case studies from around the world provide further evidence of the critical role ICT plays in disaster risk reduction. During the 2011, Great East Japan Earthquake and Tsunami, the earthquake early warning (EEW) system gave Tokyo residents a 10-second lead before tremors struck, helping shut down trains and industrial operations and reducing further casualties. In India, Cyclone Phailin in 2013, saw extensive use of Doppler radar, satellite data, and early warnings, resulting in fewer than 50 deaths, compared to over 10 000 deaths suffered in the Odisha cyclone of 1999. Cyclone Amphan 2020, involved coordinated alerts via mobile networks, social media, and community radio, enabling the evacuation of over four million people in India and Bangladesh.

Similarly, the Indian Ocean Tsunami of 2004, serves as a major failure case, where the absence of a regional EWS and coordinated ICT infrastructure, contributed to over 230 000 fatalities. This tragedy led to the establishment of the Indian Ocean Tsunami Warning and Mitigation System (IOTWS), which now includes satellite sensors, ocean buoys, and regional alert networks.

¹⁵⁴ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0536/> from Réseau International Femmes Expertes du Numérique (RIFEN)

Even slow-onset disasters like the COVID-19 pandemic can showcase the significance of ICTs. Real-time dashboards, such as the Johns Hopkins COVID-19 tracker, AI-based modelling tools, and contact tracing apps played a central role in prevention, mitigation, and recovery. In India, the Aarogya Setu app offered localized alerts, health advice, and contact tracing data to over 100 million users, underscoring how ICT is equally critical for biological and public health emergencies.

Despite these advancements, several global challenges persist. The digital divide, limited ICT infrastructure in least developed countries (LDCs) and small island developing states (SIDS), lack of interoperability due to non-standard systems, ethical concerns regarding data privacy and surveillance, and inadequate local capacity for ICT deployment all hinder progress. Bridging these gaps requires inclusive ICT policies with universal service obligations, stronger public-private partnerships, and the promotion of open-source, interoperable platforms.

Furthermore, integrating indigenous knowledge systems (IKS) with modern EWS designs, and conducting regular community-based simulation drills are essential to improving grassroots disaster preparedness. Building local capacity, and fostering inclusive participation will be key to creating resilient communities.

In conclusion, the integration of ICTs into disaster risk reduction frameworks is essential for enhancing EWSs, improving situational awareness, and ensuring timely communication, particularly in vulnerable regions. While India has made notable progress in leveraging ICT for disaster management, continued efforts are needed to bridge infrastructure gaps, address the digital divide, and promote inclusive, sustainable solutions. Strengthening public-private partnerships (PPPs) and fostering regional cooperation will be vital in building long-term resilience and safeguarding lives during disasters.

References

- **United Nations Office for Disaster Risk Reduction (UNDRR).** (2019). Global Assessment Report on Disaster Risk Reduction. <https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019>
- **International Telecommunication Union (ITU).** (2020). Using ICTs for Climate Change Adaptation and Mitigation. <https://www.itu.int/en/action/climate/pages/adaptation.aspx>
- **Japan Meteorological Agency (JMA).** Earthquake Early Warning (EEW). <https://www.jma.go.jp/jma/en/Activities/eeew.html>
- **National Disaster Management Authority (NDMA), India.** National Disaster Management Plan (NDMP), 2019. <https://ndma.gov.in>
- **India Meteorological Department (IMD).** Doppler Weather Radar Network and Cyclone Prediction Models. <https://mausam.imd.gov.in>
- **Department of Telecommunications (DoT), India.** Cell Broadcast Service for Disaster Alerts. <https://dot.gov.in>
- **National Remote Sensing Centre (NRSC), ISRO.** Applications in Disaster Management. <https://www.nrsc.gov.in>
- **Asian Disaster Preparedness Center (ADPC).** Integrating Indigenous Knowledge in Early Warning Systems. <https://www.adpc.net>

- **UNESCO.** (2023). Community Media for Disaster Risk Reduction. <https://en.unesco.org/themes/community-media/disaster-risk-reduction>
- **International Federation of Red Cross and Red Crescent Societies (IFRC).** World Disasters Report 2020: Come Heat or High Water. <https://www.ifrc.org/document/world-disasters-report-2020-come-heat-or-high-water>
- **UNDP India.** (2021). Building Resilience through Technology in Disaster Management. <https://www.in.undp.org>

A1.2 Drills and exercises for resilience and stress tests

A1.2.1 ORSEC rescue plan initiation (Algeria)¹⁵⁵

The telecommunication sector of Algeria participates in the various simulations performed by the relevant authorities pursuant to Executive Decree No. 19-59 of 2 February 2019, which, under Article 47, defines the methods for the preparation and management of rescue organization plans, involving all disaster management stakeholders.

Rescue organization plan: The ORSEC rescue organization plan is part of the State's emergency planning and organization measures to facilitate management of natural disasters and other major incidents that cause harm to human life and infrastructure losses. Pursuant to Article 3 of Executive Decree No. 19-59, the purpose of the plan is to deal with any serious incident that threatens property, persons and the environment. The rescue organization plan identifies all the human and material resources that can be mobilized in the event of disaster. It also allows for the organizing, taking, and coordinating of required actions and is organized as follows, depending on the nature and magnitude of the disaster or the resources mobilized:

- national rescue organization plan and interprovince rescue organization plan;
- province rescue organization plan and municipal rescue organization plan;
- rescue organization plan for sensitive sites.

The rescue organization plans comprise fourteen components cutting across all sectors, the most important being the connectivity and telecommunication component, for which the posts and telecommunication sector assumes responsibility. The officials responsible for this component are to provide means to ensure continuity of telecommunication services for disaster management bodies and the public, as well as the preparation and restoration of telecommunication networks for normal operations as quickly as possible.

Purpose of simulations: The primary purpose of simulations is to assess the preparedness of human and material capacities identified under the rescue organization plan, and to raise awareness of all stakeholders involved in plan components, of associated risks and of how best to deal with them, and how to respond to a disaster and manage its consequences. For the telecommunication sector, the objectives are to:

- test the connection speed of disaster-management command posts for the different satellite and terrestrial telecommunication networks, with a view to providing services necessary to coordinate interventions and crisis management;

¹⁵⁵ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0130/> from Algeria.

- test the continuity of telecommunication service operation and provision to the public in affected areas;
- enhance coordination among the different sector players, such as administrative bodies, public and private operators, including ensuring their preparedness and effectiveness for disaster response;
- train telecommunication workers and relevant teams in disaster management;
- evaluate the efficiency of telecommunication technologies and ensure that they operate properly in emergency situations.

Telecommunication sector participation in simulations: In Algeria, simulations of rescue plan initiation are run annually by the Ministry of the Interior, Local Authorities and National Planning for the 58 provinces, with participation cutting across all sectors, and according to field of expertise. The telecommunication sector participates in these exercises under the supervision of the Ministry of Posts and Telecommunications, and through the involvement of the three mobile operators, the fixed telephone operator, the space telecommunication operator, and the postal operator, as well as in coordination with other public bodies. The simulations in which the telecommunication sector participated during 2022-2023 included in particular:

- an earthquake simulation in the M'Sila province on 29 May 2022;
- a fire simulation in the Bordj Bou Arréridj province on 22 June 2022;
- an earthquake simulation in the Bouïra province on 29 May 2022.

Human and material resources: The effectiveness of telecommunication sector participation in the above simulations owed much to the involvement of all mobile phone operators, the fixed telephone operator, satellite communication operators, and Algérie Poste, as well as the participation of the National Telecommunication Directorate (DTN) in the connectivity and telecommunication component.

With respect to management of sector participation and inter-operator coordination, the Ministry of Posts and Telecommunications dealt with all technical and practical aspects, in cooperation with province directorates, with a view to harnessing the material resources of the various operators as summarized below:

- ATS satellite communication operator: provision of fast-setup fixed very small aperture terminal (VSAT) stations in order to ensure telecommunication services for disaster management centres and command posts, and provision of a mobile VSAT station providing transmission links to mobile phone operators, as well as IP phones;
- Algérie Télécom (AT) fixed telecommunication operator: provision of mobile 4G eNodeB station with built-in power supply and radio relay and fibre-optic links with a Microcell mobile base station;
- ATM Mobilis mobile operator: mobile base station providing 2G, 3G and 4G service with built-in power supply and VSAT antenna, radio relay link with accessories, and portable electric generator;
- WTA Ooredoo mobile operator: mobile base station providing 2G, 3G and 4G services equipped with VSAT station with built-in power supply and radio relay link, and portable electric generator;

- OTA Djezzy mobile operator: mini fixed base station, radio relay link with accessories, and 02 portable generator;
- Algérie Poste: mobile post office offering services to the public to provide liquidity and, in particular, the ability to communicate with relatives by sending messages via the Telegram Web application;
- National Telecommunication Directorate (DTN): VHF radios and Thuraya mobile devices.

In terms of human resources, some 80 people participated in each simulation from different sector players, including representatives of executive, control and regulatory bodies.

Conduct of simulations. Once the rescue organization plan has been put into effect, a fixed command post for all plan components is installed at the province headquarters, and the Director of Civil Protection is instructed to install an operational command post near the disaster site to manage field operations. Subsequently, the Director of Posts and Telecommunications for the province shall intervene, as the official responsible for the connectivity and telecommunication component, in coordination with the parent ministry, and DTN in the following stages:

- 1) Establish telephone service between the fixed and operational command posts through the use of DTN radios and Thuraya phones.
- 2) Establish communication via Thuraya phone with the regional directorate of Algérie Télécom Satellite for the installation of VSAT stations at the fixed and operational command points.
- 3) Establish direct communication with the different operators at the local level for an initial assessment of the condition of the telecommunication network, and to inform them of the rescue organization plan initiation for immediate intervention to provide phone and Internet services, and for immediate damage repair and network restoration.
- 4) After the initial evaluation, immediately contact via Thuraya phone representatives of the Ministry of Posts and Telecommunications responsible for the rescue organization plan in order to pass on relevant information, and to request their intervention with operators for the provision of all mobile equipment not available at the local level.
- 5) The province director, as the official responsible for the connectivity and telecommunication component, shall coordinate with local authorities and operators, and oversee all resources made available by them to ensure their use in affected areas.
- 6) Preparation of a telephone directory by the province directorate, in coordination with the various operators, in order to ensure links with the different components at both the fixed and operational command posts.
- 7) Prepare a detailed final report on the conduct and various stages of the intervention and any established shortcomings in order to prevent their recurrence.

Conclusion. The participation of the postal and telecommunication sector in the simulations was highly effective and interesting, as it allowed for different tests to be carried out on the day of the simulation, enhanced understanding of the organization and management of the rescue plan, and the gaining of more experience in various aspects, in particular:

- understanding operators' available resources and their preparedness for intervention and installation of equipment;
- enhancing coordination and establishing a complementary relationship between public and private telecommunication operators in disasters;
- strengthening coordination for the provision and exploitation of telecommunication facilities available to various public bodies.

A1.2.2 Effective use of ICT in disaster risk reduction and management training for public employees in Türkiye¹⁵⁶

The Presidency of the Republic of Türkiye Human Resources Office, responsible for overseeing the training and development of the workforce in Türkiye, coordinates numerous training activities and ensures extensive coordination among institutions. In addition to coordinating face-to-face training and development activities, the Office also offers training and development activities to all public institutions through the Distance Learning Gate (DLG) digital training platform, established on 22 April 2020. DLG has been structured to provide employees with the necessary knowledge, skills, and competencies in order to develop, and is offered free of charge to all employees in public institutions. The platform aims to provide equal opportunity in employee training, foster a learning culture, make employee training more inclusive, improve alignment to emerging skill needs, and increase the quality of training and development activities in public institutions and organizations. The platform offers public employees in both asynchronous (videos, presentations, and interactive content) and synchronous (virtual classrooms or webinars) training options. Public employees can access training activities prepared by experts in institutions that will contribute to their professional development as well as personal development. By the end of August 2024, more than 36 000 trainings were carried out, and 2.7 million public employees participated in these activities. Employees completed over 62 million trainings and earned certifications, with videos viewing adding up to 530 million views. The platform also hosted approximately 10 000 live sessions involving virtual classrooms and webinars. In addition, greenhouse gas mitigation calculation was conducted in cooperation with the Human Resources Office, the Ministry of Environment, Urbanization and Climate Change, and the Turkish Standards Institute. The objective of this study was to identify initiatives aimed at reducing greenhouse gas emissions and assess their contribution on climate change. It was determined that there was a reduction of 280 000 tons of greenhouse gases, which is equivalent to the greenhouse gas reduction provided by 12 278 854 red pine trees in one year when compared with the equivalent in face-to-face training activities.

Training and development activities at DLG were implemented after considering the professional and personal development needs of public employees in various fields. The activities are mainly in 15 training categories in order to enable public employees to keep up with innovations in various fields, generate ideas in the areas of information technologies that will facilitate their work, and acquire knowledge about the legislation they need to know while performing their work. One of these categories specifically focuses on disaster risk reduction and management training to meet the needs of public employees in that field. This focus on disaster training became especially pertinent in 2023, when Türkiye was struck by three major earthquakes centred on the Kahramanmaraş and Hatay districts on 06 February and again on 20 February 2023. The initial earthquakes, with magnitudes of Mw 7.7 in Pazarcık and Mw 7.6 in Elbistan, were followed by a Mw 6.4 earthquake in the Hatay's Yayladağı district. These earthquakes caused extensive damage across 11 provinces, resulting in over 50 000 deaths, the destruction of more than 500 000 buildings, and significant damage to communication and energy infrastructure. Affecting over 14 million people, 16.4 per cent of the total population of Türkiye, these events were among the most severe natural disasters in the country's history, with

¹⁵⁶ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0344/> from Türkiye.

profound social and economic repercussions. Training for disaster risk reduction and management plays a crucial role in increasing individuals', institutions', and communities' resilience to disasters. Disaster training: i) increases awareness of disaster risks by providing information on potential hazards in their area and the possible impacts of these hazards, ii) offers practical knowledge on how to act in different disaster situations such as fires, earthquakes, and floods, how to reach safety zones, and how to provide first aid, iii) raises awareness on various topics from simple preventive measures to be taken in homes and workplaces before a disaster, to correct interventions during and after a disaster, iv) makes communities more resistant and prepared for disasters, and so speeding up the recovery process after a disaster, and v) provides guidance on how authorities and volunteer organizations can coordinate, ensure information flow, and communicate with the community during disaster situations. Additionally, the trainings to be conducted for public employees aim to contribute to their more effective, conscious, and coordinated performance of tasks such as search and rescue, evacuation, first aid, sheltering, and security in emergency situations. The in-service training programmes structured in this context focus on preparing workers for their role and response in disaster situations. Various organizations offer both face-to-face, and online training sessions to support these efforts and enable public servants to contribute effectively during rescue and relief operations.

Pre-earthquake training activities. In the context of disaster risk reduction and management, a range of disaster preparedness trainings were available on the distance learning gate (DLG) prior to the earthquakes of 6 and 20 February 2023. These trainings, provided in asynchronous video format, allowed public employees to access them at any time and from any location. Table A-1 shows the training titles, the providing institutions, the number of personnel trained, and the number of views.

Table A-1: Summary of Disaster Preparedness Trainings Offered on DLG before the Earthquake

Training title	Providing institution	Number of unique users (up to 6 February 2023)	Total repeated views (up to 6 February 2023)
Disaster awareness training	Ministry of Interior Disaster and Emergency Management Presidency	482 282	898 672
Disaster awareness training for individuals and families	Ministry of Interior Disaster and Emergency Management Presidency	139 569	228 809
AFAD emergency mobile application	Ministry of Interior Disaster and Emergency Management Presidency	36 476	82 973
Earthquake preparedness and urban transformation awareness training	Ministry of Environment, Urbanisation and Climate Change	4 735	11 850
Total		537 524	1 222 543

As can be seen in Table A-1, over 500 000 public employees have participated in at least one of the disaster awareness courses offered through the platform.

Post-earthquake training activities. Immediately following the earthquake of 6 February 2023, the Ministry of Family and Social Services responded to requests from personnel working in the field by offering psychosocial support to disaster victims. The Ministry provided both synchronous and asynchronous training through DLG to approximately 15 000 employees scheduled to work on-site.

A webinar programme was organized on 22 and 24 February, with 5 223 personnel attending the session on 22 February and 4 879 personnel participating in the session on 24 February.

Webinar content

- Preparation for the disaster zone
- Services in the disaster zone and referral mechanisms
- Psychological first aid
- Ethics and code of conduct in the field

In addition to the webinar programme, the trainings detailed in Table A-2 were provided asynchronously in video format through the DLG.

Table A-2: Summary of psychosocial support trainings offered on DLG after the earthquake

Training title	Date added	Number of unique users	Total repeated views
Supporting employees in disasters and emergencies	15 March 2023	82 232	246 860
Reactions in Children after Disasters and Emergencies and Recommendations for Families	15 March 2023	65 909	183 194
Reactions in Adults after Disasters and Emergencies	15 March 2023	95 639	286 672
Grief Reactions in Children and Recommendations for Families	15 March 2023	62 996	201 535
Privacy in Children: Important Considerations During Disaster Periods	18 April 2023	65 837	185 292
Period of Loss and Grief in Adults	15 March 2023	77 086	222 610
Total		173 399	1 326 164

Table A-2 shows that more than 170 000 public employees have taken part in at least one of the psychosocial support courses available on the platform.

In the context of disaster risk reduction and management efforts, a "Disaster awareness training programme" was developed to target all public employees, and not just a specific group of employees. Initially, a coordination meeting was held with the units responsible for training and development in 17 ministries to discuss the framework and content. Subsequently, a workshop was conducted with designated personnel from each unit to finalize the programme outline. As a result of extensive coordination and efforts, a training programme of an approximately 4-hour duration, consisting of five modules and 61 videos, was made available to all public employees (see Table A-3). This

training programme was developed with contributions from seven institutions, including the Ministry of Interior Disaster and Emergency Management Presidency, four ministries, a relevant non-governmental organization, and a university (see the advertisement of the programme: Option 1: Dubbed in English¹⁵⁷, Option 2: Original with English subtitles¹⁵⁸).

Table A-3: Summary of the 'Earthquake awareness' training programme

Training title	Number of unique users	Total repeated views
Module 1: Introduction to earthquake awareness training programme	1 511 581	5 421 630
Module 2: Basic information about earthquakes and the seismicity of Türkiye	1 423 553	4 259 287
Module 3: Preparing for an earthquake	1 341 202	3 689 371
Module 4: What to do during and after an earthquake	1 282 497	3 493 715
Module 5: Guidelines for personnel in earthquake zones	1 260 941	3 318 411
Total	1 517 844	20 182 414

Each module within the training programme includes assessment tests at the end to evaluate understanding. At the end of the training programme, a survey was completed by 247 611 participants, and the overall satisfaction rate for the training programme was determined to be 96 per cent.

In conclusion, ICT has been used effectively and efficiently in disaster risk reduction and management, achieving satisfactory outcomes. Both synchronous and asynchronous communication technologies have been utilized appropriately in training and development activities according to the needs. As a result of these training and development activities, the public employees who participated in activities in the disaster zone were able to carry out post-disaster processes in a more effective, efficient, and coordinated manner, and the level of awareness of all public employees was increased.

A1.2.3 Measures to ensure the resilience of telecommunications services during monsoon storms and floods (Malaysia)¹⁵⁹

Malaysia experienced massive floods from 15 December 2014 to 3 January 2015, which many locals described as the worst the country had experienced in decades. More than 500 000 people in the east coast area of Malaysia were affected. States in Kelantan, Terengganu, and Pahang were hit hardest. Tragically, 21 people were killed by the floods. Communication services in the affected areas were inaccessible as telecommunication towers were destroyed or severely damaged. The 2014 floods led the Government of Malaysia, through its agencies, to take urgent steps to ensure communication services remain accessible during disasters in future. Today, early flood warnings are now disseminated via 'SMS blast', a tool for sending bulk messages, to urge people to relocate to safer areas based on weather warnings. Telecommunication infrastructures are considered as critical assets that remain in operation during the floods. The Malaysian Communications and Multimedia Commission (MCMC)

¹⁵⁷ https://cbiko.gov.tr/uploads/u/EarthquakeAwarenessProgram_DubbedVersionwithSubtitles.mp4

¹⁵⁸ https://cbiko.gov.tr/uploads/u/EarthquakeAwarenessProgram_OriginalwithSubtitles.mp4

¹⁵⁹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0342/> from Malaysia.

and telecommunications industry players have jointly invested to ensure that communications towers in flood prone areas are flood-proof, through a 'site-hardening' programme.

SMS blast: To increase access to information regarding early flood warnings to the affected public, the Department of Irrigation and Drainage (DID), through the National Flood Prediction and Warning Centre (PRABN), and the National Disaster Management Agency (NADMA) have collaborated with MCMC in disseminating warning announcements through the SMS blast system. As of March 2024, a total of 11 031 430 disaster early warning SMS messages have been sent by mobile network operators (MNOs) and mobile virtual network operators (MVNOs) to the public.

Figure A-14: Image of SMS blast (1)

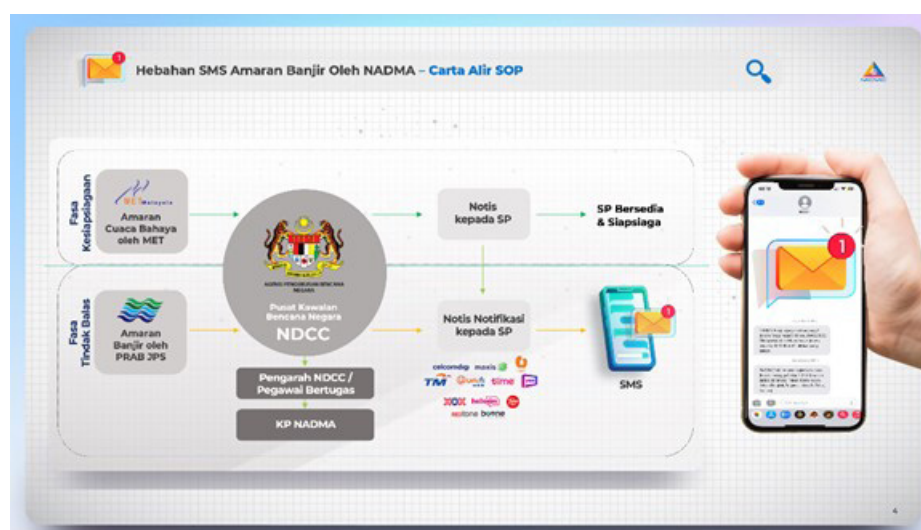


Figure A-15: Image of SMS blast (2)



Site hardening: During the major flood of 2014, communications in flooded areas were disrupted by flood damage to telecommunication transmitter structures. As a result, MCMC collaborated with the telecommunications industry to re-design the sites to be more resilient to disasters. A total of 429 telecommunications transmitter structures (towers, etc.) were completed and strengthened by service providers between 2021 to 2024, and this 'site hardening' resulted in a significant reduction in service outages.

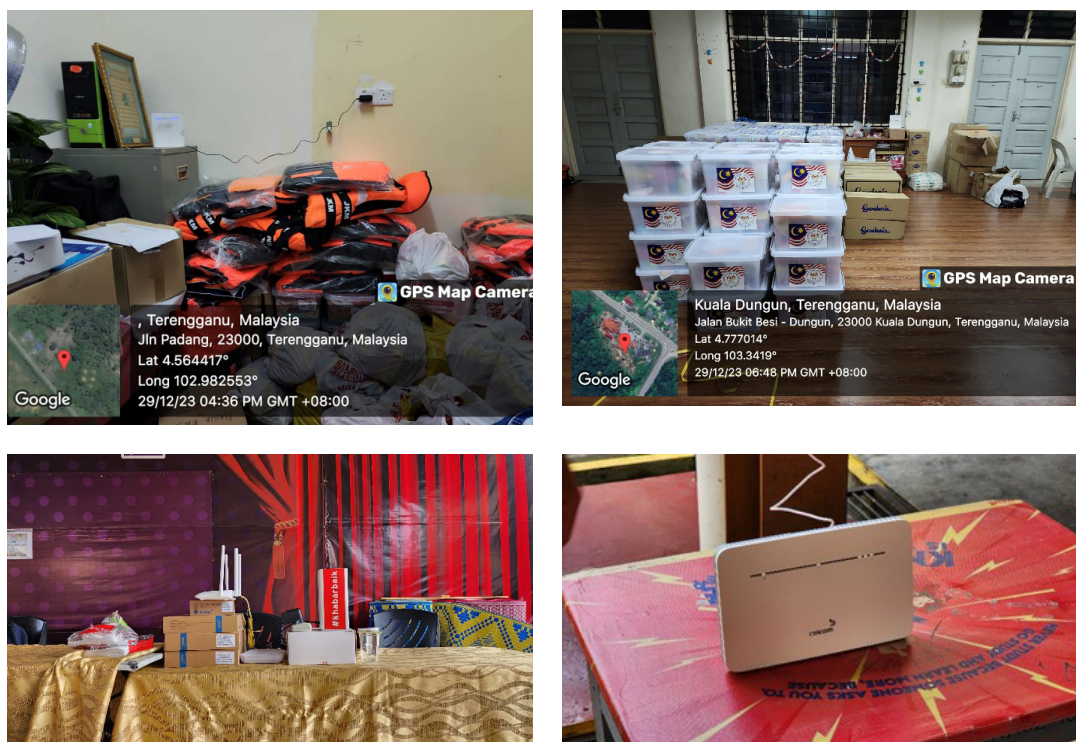
Figure A-16: Site hardening



Coverage at temporary placement centres. MCMC monitors complaints from the public on poor quality of service at temporary placement centres for disaster victims. Officers from MCMC State Offices carry out desktop analysis and quality of service (QoS) testing at the centres. In an effort to comfort the victims affected by the flood, the telecommunications company installed free Wi-Fi service at these selected centres to enable flood victims, who have taken shelter, to obtain decent quality Internet and telecommunication access.

From December 2022 to March 2024, a total of 70 temporary placement centres nationwide have benefitted from the free Wi-Fi service provided by the service providers. This initiative shall continue for the coming monsoon season. Some of the criteria for selecting the free Wi-Fi installation initiative were based on the assessment of the quality of service at the relief centres, whether the number of flood victims involved exceeding 200 people, and those relief centres that have a record of being open for more than 72 hours.

Figure A-17: Pictures of a temporary placement centre



A1.2.4 Forest fire prevention (Algeria)¹⁶⁰

Forest fires are a recurring threat, in particular during summer. They can cause significant damage to biodiversity, the environment, infrastructure and homes. Prevention is therefore necessary to reduce risks and mitigate the impact of forest fires. In this context and in order to promote forest fire prevention, the Ministry of Posts and Telecommunications has launched a national prevention campaign in collaboration with the General Directorate of Forestry and the three national mobile operators and the fixed operator.

Objective of the prevention campaign. The main objective of this initiative is to:

- enhance the security and protection of telecommunication infrastructure in forested areas, and forest fire prevention and protection;
- reduce the risk of, and mitigate damage to telecommunication infrastructure caused by forest fires;
- ensure continuity of telecommunication services in forested areas, even in the event of fires;
- develop a detailed list of GPS coordinates for the various operators' telecommunication infrastructure in forested areas.

¹⁶⁰ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0131/> from Algeria.

Implementation of the prevention campaign. Following the roadmap developed by the Ministry of Posts and Telecommunications, in collaboration with the General Directorate of Forestry, and telecommunication operators, the forest fire prevention campaign was implemented in two phases as follows:

Phase I – Organization of field visits. During this phase, field visits were organized in the 39 provinces with forested areas in order to examine all telecommunication facilities located in national forest estates and to:

- verify compliance of telecommunication sites with applicable standards and regulations for forest fire prevention;
- assess the risks of forest fires at these sites and develop appropriate preventive measures to reduce them;
- obtain recommendations and directives from the forestry services on preventive actions to be carried out at each site;
- develop a detailed database listing the telecommunication facilities in forested areas with their geographical coordinates.

In this context, some 780 sites were examined across the various operators, with 586 requiring preventive action to mitigate the risk of forest fires and protect telecommunication infrastructure.

Phase II – Completion of necessary preventive action by telecommunication operators. Following completion of the inspections, which allowed each site to be assessed individually, a list of reservations and directives established by the forestry services was sent to the telecommunication operators concerned, which proceeded to demonstrate a strong commitment in addressing the reservations raised. The work was completed at the beginning of June 2023, and focused for the most part on the following actions:

- establishing a safeguarding bare strip of land between 2 and 25 metres wide that is devoid of any vegetation;
- remove weeds and small shrubbery surrounding telecommunication towers and within and outside sites;
- cut down trees located too close to telecommunication sites in the presence of representatives of the forestry services;
- trim trees surrounding telecommunication site fences and enclosures.

Assessment of the prevention campaign. The campaign proved successful and Figure A-18 and Figure A-19 show the scope of the prevention campaign process, which was carried out at national level and implemented in record time.

Figure A-18: Number of telecom sites

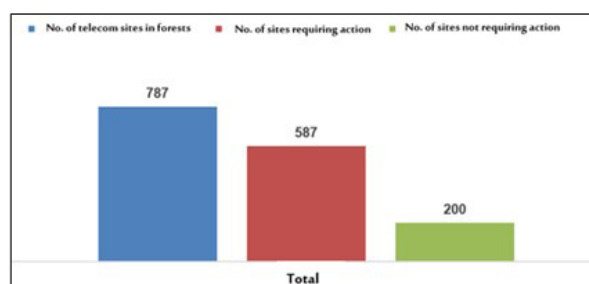
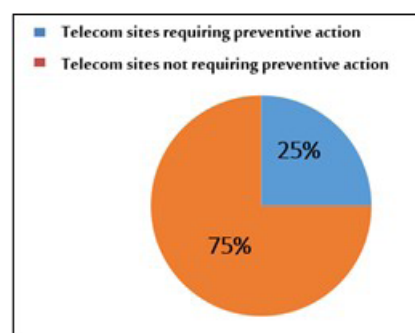


Figure A-19: Number of telecom sites requiring action



Conclusion: The campaign that was launched by the Ministry of Posts and Telecommunications, and implemented by telecommunication operators to prevent fires in areas surrounding telecommunication facilities, was highly successful thanks to the close cooperation with the General Directorate of Forestry. All those that participated in the campaign demonstrated great commitment through persistent efforts to implement the preventive measures identified by the forestry services. For their part, the forestry services expressed great satisfaction with, and appreciation for, the campaign to prevent fires in the vicinity of telecommunication facilities. Furthermore, they acknowledged the efforts of the telecommunication sector and stressed the importance of taking such a proactive approach. Such an approach contributes significantly to reducing the risk of fires, and to enhancing the security of telecommunication infrastructure.

A1.2.5 Practices for enhancing the ability of emergency communication teams, and the level of emergency communication equipment (China)¹⁶¹

Background: The occurrence of extreme natural disasters often results in the destruction of telecommunication facilities, leading to regional communication interruption. So, while rapid repair of communication networks is necessary, it is also critical for emergency communication teams to be able to use advanced technology and equipment to temporarily and quickly establish a communications connection. The professional skills and equipment level of emergency communication support personnel, directly affect the quality and efficiency of efforts to rapidly repair and re-establish communications. Over the past few years, the Ministry of Industry and Information Technology (MIIT) of China, have organized various practical activities to improve the skills and equipment capabilities of emergency communication teams. Their purpose was to promote mutual learning and joint improvement among teams, to explore suitable technology and equipment, and to promote their application, and in this way enhance emergency communication support capabilities of emergency communication teams for extreme disaster scenarios.

Practices for improving the capability of emergency communication teams and equipment. China managed to achieve an effective integration of team capability enhancement, and equipment capability improvement, through use of methods such as skills competitions for emergency communication teams, research, and application demonstrations of specialized equipment. These practices involved assessing the theoretical knowledge and operational skills of the national emergency communication support teams, as well as exploring and promoting advanced and applicable technology and equipment for extreme scenarios.

a) Team capability enhancement practices

¹⁶¹ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0223/> from China.

In 2023, the first nationwide emergency communication skills competition was held, with the aim of comprehensively examining the theoretical knowledge and practical operation proficiency of the support teams. In the long run, it can promote the consolidation of foundational skills, foster mutual learning, enhance collaboration among teams and groups, establish a talent pool for emergency communication support, and improve the national emergency communication support capabilities for extreme events. The skills competition consists of two stages, which are a theoretical examination and a practical operation assessment. The theoretical examination is conducted in a closed-book format on-site, and covers knowledge of management systems, emergency communication, safe operation, and wilderness survival. The practical operation assessment involves on-site timed operations and includes three examination subjects. Subject one involves the activating of public network base station services based on satellite communication, which is used to be rapidly deployed to the scene and provide public communication services in response to sudden disaster scenarios. The purpose of this subject is to assess the level of proficiency in operating satellite communication equipment, the capability to quickly activate 4G base station services, and the team's emergency response capabilities. Subject two involves the activating of 5G portable base station services based on the bridging capabilities of portable microwave stations, which are used to enhance network coverage in complex geographical environments. The purpose of this subject is to assess the team's capability for on-site equipment assembling and debugging, the capability to quickly activate 5G portable base station services, and the team's physical fitness and resilience to pressure. Subject three involves troubleshooting fibre-optic cable, throwing, and laying fibre-optic cable, crossing an obstacle zone, and fusing optical-fibre, which is used to rapidly build fibre-optic cable connections when ground transmission lines are damaged. The purpose is to assess the team's capabilities for on-site laying of cable while overcoming obstacles, fusing fibre-optic cable, and operating with precision. The skills competition effectively stimulated the enthusiasm of the team members to study and learn professional skills, it examined and helped to cultivate a group of highly skilled and qualified professionals, and served to optimize and improve the talent pool. At the same time, it evaluated the application and level of capabilities of emergency communication equipment, contributing to identifying any shortcomings and issues with the equipment.

b) Equipment capability enhancement practice

Starting in 2021, the MIIT has organized a number of specialized research and development initiatives for emergency communication technology and equipment. To address the specific communication needs of extreme disaster scenarios and address the inadequacies of equipment exposed during typical event responses, specialized engineering directions have been established, such as integrated satellite communication, UAV-based mobile communication, etc. These specialized engineering directions focused on core elements such as equipment communication capabilities, and the environmental adaptability of equipment. This initiative guides collaborative research, development, testing and the application of efforts among industry and university research. The goal is to enhance the consistency and reliability of equipment, and address issues related to engineering transformation and promotion. In 2022, China Academy of Information and Communications Technology (CAICT) carried out an initiative to obtain advanced equipment. To address the communication support needs in scenarios such as earthquakes, floods, forest fires, maritime search and rescue, and nuclear accidents, an open solicitation was conducted to collect both proven mature equipment and prototypes, that focus on solving practical problems in specific environments, that demonstrate advanced technical indicators, significant application effectiveness, and considerable potential for widespread adoption. A comprehensive evaluation of the shortlisted equipment was carried out, leading to the discovery and promotion of a collection of technologically advanced and practically useful emergency equipment. In 2023, MIIT organized an exhibition to display advanced emergency communication technology and equipment. Physical exhibition areas combined with desktop sand tables were utilized. The exhibition areas were set up for different stages of disaster management, including monitoring and early warning, centralized resettlement support, communication support in the case of power and network outage, and support for scenarios of simultaneous road, power, and network disruptions. The exhibition highlighted the integrated application of various support means, including satellite communication equipment, cluster base stations, broadband microwave technology, drones, 'robot dogs', and all-

terrain vehicles. The exhibition provided a visual representation of communication support measures and equipment applications in the event of major disasters through static explanations, dynamic demonstrations, case displays, interactive discussions, etc.

Summary. The professional competence and equipment level of emergency communication support teams directly affect the effectiveness and quality of support. It is therefore necessary for teams to conduct regular skill competitions, improve talent pool development, enhance team collaboration, and effectively strengthen the practical comprehensive capabilities. Efforts should also be made to explore advanced and applicable technology and equipment, tackle issues in industrial engineering applications, promote high-end practical equipment, and effectively drive the improvement of emergency communication equipment capabilities.

A1.2.6 Enhancing disaster resilience through telecommunications and ICTs in the small island developing states of the Pacific Ocean (Samoa)¹⁶²

About SAMOA: Samoa is situated in the central South Pacific Ocean, among the westernmost of the island countries of Polynesia. It has nine volcanic islands in its archipelago, four of which, Savai'i, Upolu, Manono and Apolima make up more than 99 per cent of the land. Almost a quarter million people live in the principal capital and villages across the coastal areas. Society in Samoa is centred around the extended family, headed by an elected chief who directs the family's social, economic, and political affairs, and the church, which is a focus of recreational and social life. The economy revolves around fishing and agriculture, and it is vulnerable to cyclones, earthquakes, floods, and disease. Attempts at diversification have met with success. Tourism is growing, thanks to the numerous scenic attractions and fine beaches. Offshore banking spearheads an expanding services sector. Light manufacturing is expanding and has attracted foreign investment. Samoa has a national airline as well as inter-island maritime services. Despite its natural resources and potential for economic growth, Samoa faces several challenges, including vulnerability to natural disasters, climate change, limited market access, and high dependence on imports. The Government is working to address these challenges through policy reforms, diversification strategies, and international cooperation. Regarding telecommunications infrastructure, Samoa is served by fixed lines, mobile cellular services, and satellite services with gateway connectivity.

Statement of the situation or problem: Telecommunications and ICTs are crucial in disaster mitigation, preparedness, response, and recovery. Samoa and other countries bordering the Pacific Ocean witness significant disaster events annually, demonstrating the critical need for resilient disaster communications and management systems in this vulnerable region. These countries, especially SIDS can bolster their preparedness, response, and recovery efforts by harnessing technological advancements. Resilient communication infrastructure, including satellite networks, ensures continuous connectivity during emergencies, and facilitates coordinated response efforts. Strengthening the capacity of local institutions through training programmes and fostering partnerships with regional and international stakeholders further enhances disaster resilience in the Pacific region. By integrating telecommunications and ICTs into comprehensive disaster management strategies, Samoa and Pacific SIDS that are vulnerable to disasters can better protect infrastructure and livelihoods from the impacts of natural disasters. The present report addresses efforts that can be undertaken to enhance disaster resilience through telecommunications and ICTs in Samoa and Pacific SIDS.

Leverage terrestrial and satellite technologies for disaster resilience: Terrestrial and cable technologies are vulnerable to exposure to natural hazards prevalent in the Pacific region. Events such as cyclones, earthquakes, and volcanic eruptions pose significant risks to these infrastructure components, leading to disruptions in communication networks. Moreover, the Pacific island SIDS and territories' remote and dispersed nature presents challenges to the deployment of terrestrial fibre-optic networks across the entire region. Financial constraints further limit the ability of

¹⁶² ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0217/> from Samoa.

telecommunications service providers to invest in fibre-optic technology, particularly in rural and remote areas. In response to these challenges, there is a growing reliance on satellite networks as vital components of disaster-resilient communication systems in this region. Satellites offer resilience to physical damage, making them ideal for providing crucial connectivity in remote and disaster-prone areas. Satellite broadband networks offer several advantages in disaster scenarios. Portable very small aperture terminals (VSAT) antennas, hand-held terminals, and temporary installations can be rapidly deployed post-disaster to bolster communication efforts. Additionally, satellites equipped with software-defined (SDS) technology enable dynamic capacity allocation in areas of higher need, enhancing network resilience, and supporting emergency response activities. Lastly, satellite backhaul solutions play a critical role in ensuring connectivity in remote regions and serving as backups for critical terrestrial infrastructure. Many Pacific SIDS, territories and other countries already possess significant satellite antenna infrastructure, which can be recommissioned with minimal investment to enhance disaster resilience. By leveraging terrestrial and satellite technologies, Samoa and other Pacific SIDS can strengthen and improve their disaster resilience and ensure continuity of communication during emergencies.

Analysing national experiences and best practices

Capacity building: Governments need to prioritize capacity-building initiatives to enhance disaster management capabilities. One way to do this is to provide training programmes for local institutions and stakeholders involved in disaster response and recovery efforts.

Partnerships and collaboration: Collaborative efforts among governments, regional and international organizations, NGOs, and the private sector are essential. By fostering partnerships and sharing experiences, best practices, and lessons learned, SIDS and countries in the Pacific region can strengthen their disaster resilience. This collaborative approach also facilitates the exchange of resources, expertise, and technologies to enhance disaster preparedness and response. The role of ITU is essential in this collaboration through capacity building and its Partner2Connect (P2C) initiative, which fosters partnerships and resources mobilization for implementing critical telecommunications infrastructure projects.

Regulatory and policy initiatives

Exemptions and streamlined procedures: Regulatory constraints often hinder the rapid deployment of telecommunications infrastructure during emergencies. Governments should implement exemptions from licensing and customs clearance procedures during disaster situations to expedite the deployment of critical telecommunications equipment and technologies. Regulators should consider amending the Telecommunication Acts to provide exemptions from licensing, and type approval requirements to ensure fast deployment of telecommunications infrastructure during emergencies. Streamlined regulatory processes ensure that telecommunications providers can quickly establish or restore connectivity in affected areas without bureaucratic delays.

Investment incentives: Encouraging investment in resilient telecommunications infrastructure requires creating favourable regulatory environments and offering investment incentives. Governments can provide tax breaks, subsidies, or other financial incentives to telecommunications operators and infrastructure providers willing to invest in disaster-resilient networks. Removing regulatory barriers and offering investment incentives in times of disasters can attract private sector investment in disaster-resilient telecommunications infrastructure.

Desired outcomes: In conclusion, the submission proposes a multi-faceted approach to enhancing disaster resilience in Samoa and other SIDS of the Pacific Ocean region, through telecommunications and ICTs. By leveraging terrestrial and satellite technologies, countries can overcome the vulnerabilities of traditional infrastructure and ensure continuous communications during emergencies. Capacity-building initiatives, partnerships, and collaboration among governments, regional and international organizations, and the private sector are crucial for strengthening disaster management capabilities.

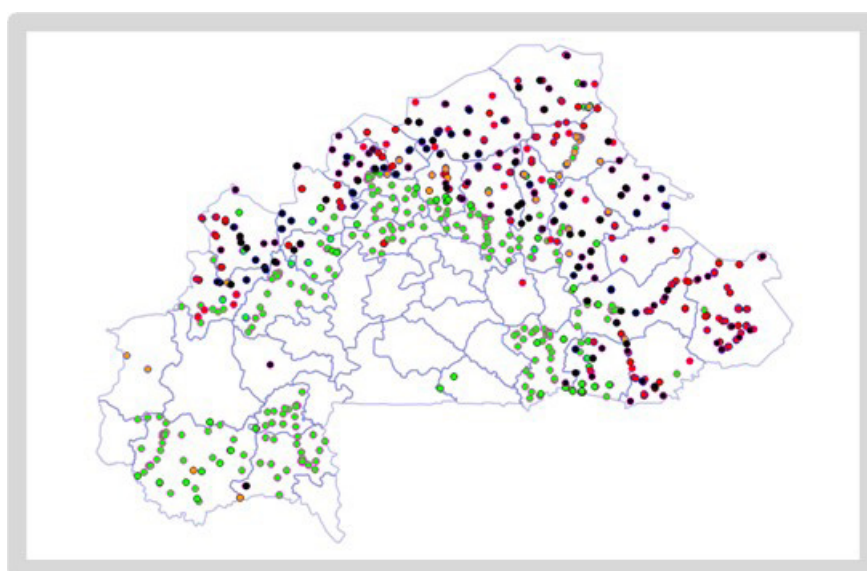
Regulatory and policy initiatives, including exemptions, streamlined procedures, and investment incentives, are essential for encouraging investment in resilient telecommunication infrastructure.

A1.3 Enabling policy and regulatory environment

A1.3.1 Resilience of telecommunication infrastructure in Burkina Faso (Burkina Faso)¹⁶³

Telecommunications infrastructure has become a prime target for armed terrorist groups operating in certain parts of the country. Attacks and acts of vandalism against physical installations and radio sites by armed groups are aimed at isolating people from the affected areas. These attacks are on the rise and pose a challenge to the provision of electronic communications services. Indeed, an inventory of telecommunications services established on 30 June 2022, shows that among the 812 sites identified in insecure areas, 418 were out of service or vandalized. This inventory shows that 11 regions out of 13 were impacted, with strong pressure in the sites of the North, East, North Central, and East Central areas and increasingly the West.

Figure A-20: Situation of sites in insecure areas as at 30 June 2022



This situation has a strong impact on the digital sector and presents many challenges for consumers in the affected areas, but also for public authorities and telephone operators. Consumers in insecure communities no longer have much access to digital services, nor to emergency and security services. Similarly, they face interruptions of financial transactions with mobile money and inaccessibility to social networks. For the State and the public authorities (notably the Regulatory Authority), the consequences of the damage to radio sites and other electronic communications facilities are reflected in the dysfunction of the intelligence services in the affected localities, and in the difficulties in obtaining the cooperation of the population in the fight against all forms of violence. It should also be noted that the efforts of telephone operators to ensure the maintenance of radio sites, and to re-establish radio sites are greatly hampered by the difficulties of access to these infrastructures. Finally, public initiatives to ensure the coverage of white areas through, for example, the universal service fund (USF), are finding it difficult to implement them, further accentuating the digital divide in the country and the isolation of the populations of the localities under the influence of terrorist groups. Aware that

¹⁶³ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0052/> from Burkina Faso.

the physical isolation and digital isolation of populations in insecure areas constitutes an additional challenge in the fight against armed groups, and with the aim of ensuring the resilience of populations in the face of terrorism, the Government of Burkina Faso has adopted a series of measures, one of which is the re-establishment of electronic communications infrastructure in areas experiencing a high security challenge. The ultimate objective of this measure is to ensure the availability and accessibility of electronic communications to consumers throughout the country. Beyond this objective, it is above all a question of ensuring the continuity of the State throughout the territory. The implementation of this measure is entrusted to a multidisciplinary working group composed of public administrations (Ministry, Regulatory Authority, Defence, and Security Force) and telephone operators established under the auspices of the Ministry of Digital Transition, Posts and Electronic Communications.

Inventory of radio sites destroyed or vandalized

Overview and mapping of non-functional telecommunication sites

The approach consists initially in drawing up an exhaustive and precise inventory of radio sites and telecommunication infrastructures destroyed or vandalized, by mapping for each operator the vandalized sites or non-functional sites. Thus, on the basis of the data collected from the three national telecommunication operators, the total of unavailable sites was estimated at 418 sites on 31 December 2022, as shown in Figure A-21 and Figure A-22.

Figure A-21: Evolution of the number of telecommunication sites out of service due to the security situation 2019-2022

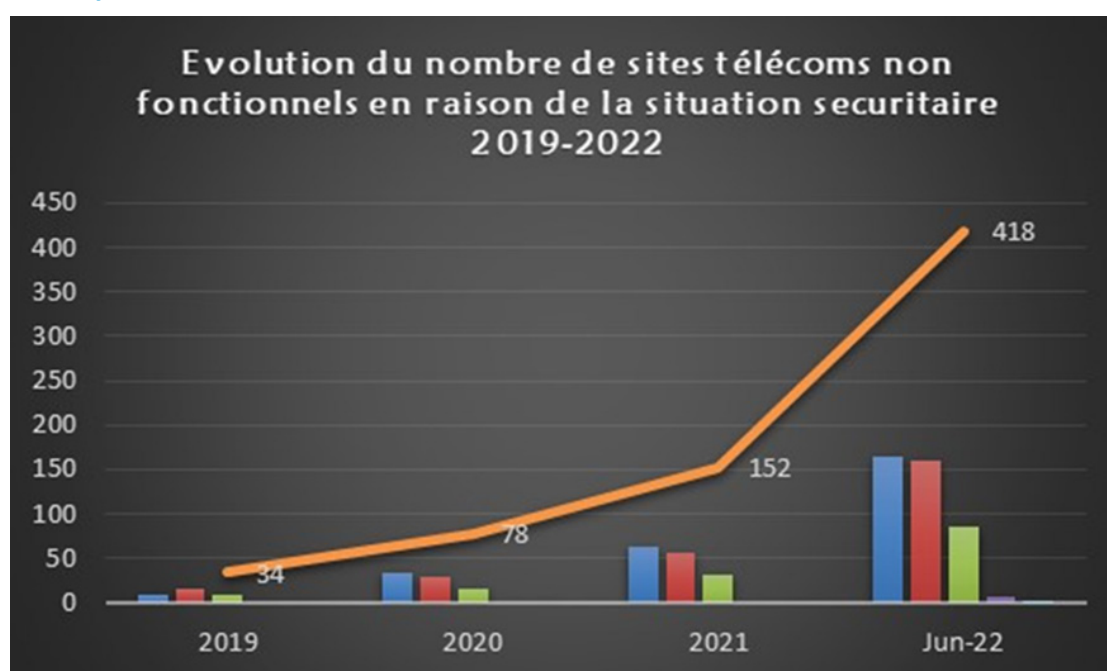
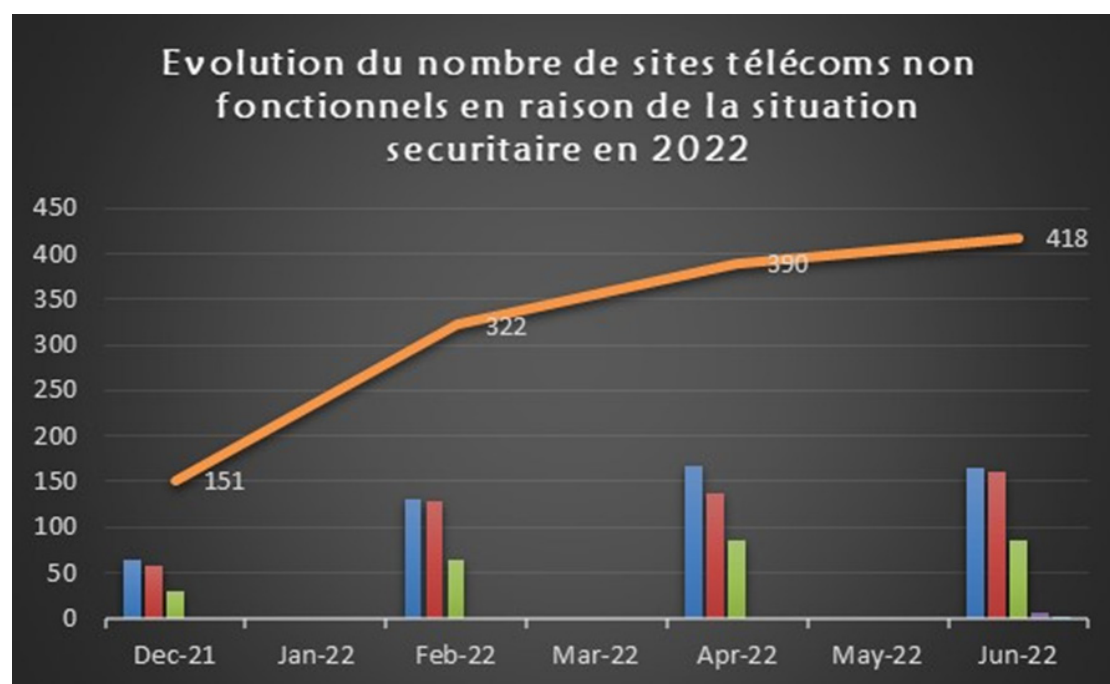


Figure A-22: Evolution of the number of telecommunication sites out of service due to the security situation in 2022



These trends and data lead to the conclusion that the armed groups have a good knowledge of the operators' transport networks and exert strong pressure to isolate the population in the northern and eastern parts of the country.

Identification of criteria for selection of sites for restoration. On the basis of a realistic approach taking into account the constraints on the ground, the Working Group identified criteria for selecting the telecommunication sites to be restored. These criteria are as follows:

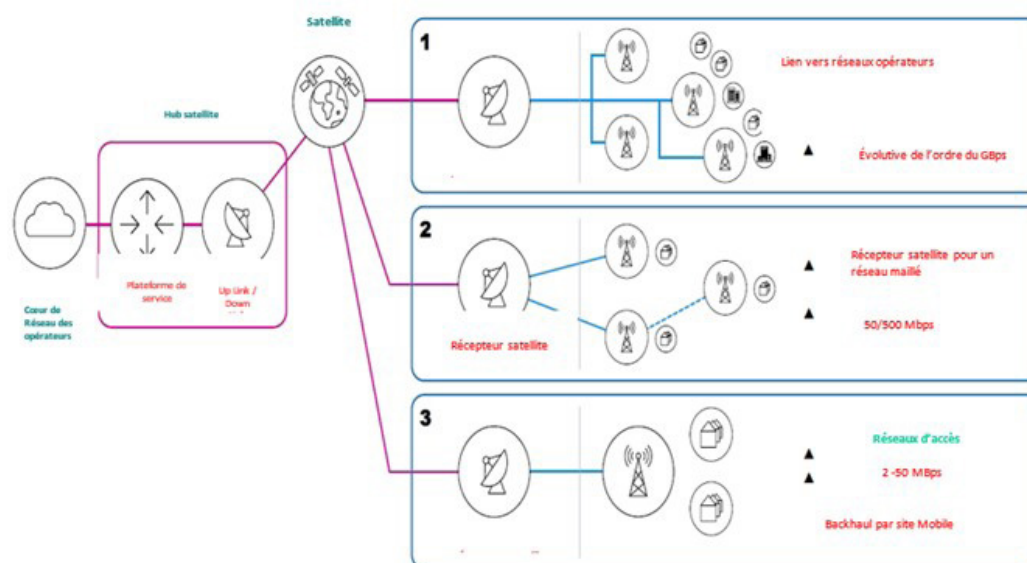
- Sites that can be secured during and after service is restored;
- Sites in the vicinity of military camps;
- Sites located in large agglomerations.

In accordance with the above criteria, 50 sites were selected, of which 25 were considered priority sites.

Recovery of selected telecommunication sites

Technology choice: Starting from the security constraints on the ground and the need to ensure the safety of the sites after their recovery, several technical and technological solutions were explored for this purpose. After analysis, satellite solutions were deemed to be the most appropriate in view of the current security situation, and of the network architecture of the telecommunication operators. Specifically, it is a question of creating a satellite hub in the capital at which operators will interconnect their networks. From this hub, each of the 25 sites can be interconnected via satellite links.

Figure A-23: Architecture



Technology solution financial assessment and support details: The estimates collected from operators indicate that the implementation of such a project requires a period of at least 4 months from the choice of the selected service provider outside the time limits linked to the procurement procedures. For financing, a co-investment approach was considered. The costs of repairing all the components of the impacted sites will be borne by the operators involved, while the Government will cover the costs of establishing satellite transmission links through the 'Support Fund for the Implementation of Exceptional Measures in the Electronic Communications Sector.' This Fund is a legal and financial mechanism established by Act n°061-2008/AN of 27 November 2008, regulating electronic communications networks and services. The terms for the use of the Fund were set out in Decree n°2020-536/PRES/PM/MDENP/MINEFID of 30 June 2020, defining the terms for the use of the Fund for the implementation of exceptional measures in the electronic communications sector. According to Article 2, the Government may use the Fund to finance three types of measures, including "measures for the restoration of emergency communications in the event of disasters or crises".

A1.3.2 Strengthening telecommunications against natural disasters (STAND) (Australia)¹⁶⁴

As in many parts of the world, Australia has experienced a number of extreme weather events in recent years. In the 2019/2020 summer, large parts of the country were affected by severe bushfires following hottest and driest year on record in Australia. These bushfires resulted in loss of human lives; the death or displacement of an estimated 3 billion animals; and the destruction of tens of millions of hectares of land and thousands of properties. Since then, a succession of La Nina weather events has caused significant flooding impacting many communities across Australia over 2022. The flooding has affected the everyday lives of many Australians, with many areas of the country experiencing their wettest year on record. Disasters such as these represent an increasingly significant challenge for the resilience of Australia's telecommunications networks. For example, approximately 1 400 telecommunications facilities were impacted across Australia during the 2019/2020 bushfires, either directly or indirectly. Likewise, during a particularly extreme flooding event in March 2022, along the eastern coast of Australia, approximately 900 telecommunications facilities were impacted. As a result of these major outages, many communities in both instances were left isolated and without any ability to:

¹⁶⁴ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0065/> from Australia.

- contact their friends, family or emergency services;
- receive emergency warnings from Government;
- access emergency information such as the location of evacuation centres; and
- use payment systems (such as EFTPOS) to purchase essential supplies such as food, water or fuel, or access government financial assistance.

These impacts, especially during an active disaster, can delay response and recovery efforts, put lives at risk, and compound the devastating impact and subsequent trauma experienced by communities.

Australian emergency management arrangements. The Australian Federal Government (the Government of Australia) has an overall responsibility for telecommunications. This includes managing policy and regulatory settings for the sector, as well as providing grant funding to encourage certain activities such as expanding mobile coverage in regional and remote areas. However, the primary responsibility for disaster response sits with State and Territory Governments (eight in total), while the direct operation and maintenance of networks is the responsibility of the telecommunications carriers in Australia. This division of responsibilities means that when a disaster occurs, telecommunications carriers will work directly with the relevant State or Territory Government, in accordance with the emergency management arrangements within that jurisdiction. In this context, the main role of the Government is to help prepare the telecommunications sector to respond to and recover from disasters. In practice, the State and Territory Governments often work with the telecommunications sector to prepare for disasters, and this includes involving telecommunications carriers in emergency planning. Meanwhile, the Government provides broad assistance to telecommunications carriers where necessary to support response and recovery efforts.

For example, during a severe flooding event impacting the northwest coast of Australia in January 2023, floodwaters destroyed a major arterial bridge which held fibre-optic cables in a very remote region, causing major outages on the other side of the river, with many communities being unable to contact emergency services. In response, the Australian Government provided assistance in the form of military aircraft to transport technicians from a telecommunications carrier to the other side of the river. This support enabled the technicians to rapidly repair the fibre-optic connection and restore connectivity.

Figure A-24: Division of responsibilities



Case study: Strengthening telecommunications against natural disasters (STAND) package. The Government of Australia has been strengthening the telecommunications sector against disasters through a range of actions over the past three years. Recognising the serious impact of the 2019/2020 bushfires on telecommunications networks in Australia, the Government has been implementing the 'Strengthening Telecommunications Against Natural Disasters' (STAND) package. The STAND package comprises four key measures:

- a) **Mobile Network Hardening Programme:** Upgraded the battery back-up power to a minimum of 12 hours at 461 mobile base stations across Australia to date;
- b) **Sky Muster Satellite Service Deployment Programme:** Installed fixed satellite services at 1 086 evacuation centres and emergency service depots across Australia, which can provide free backup connectivity via satellite;
- c) **Temporary Infrastructure Deployment Programme:** Expanded the availability of portable assets such as 'cells on wheels', and portable satellite kits which can provide temporary coverage following a disaster; and
- d) **Communications Programme:** Developed communications material and other resources for stakeholders to use in an effort to improve general community awareness and preparedness for telecommunications outages during disasters.

The STAND package has had a real impact in improving the availability of telecommunications during natural disasters to date. For example, during the March 2022 floods along the eastern coast of Australia, temporary facilities funded under STAND were deployed to evacuation centres in flood-affected areas across the state of New South Wales, providing critical connectivity for evacuated residents in time of need. Lessons learned through implementation of measures 2 to 4 of STAND (item 1 is still being delivered):

- It is critical to work with emergency services stakeholders to deliver this type of programme. The stakeholders know what services they require and where they need them.
- When deploying multiple services over the entire country, the local (state level) engagement and interest in the programme makes all the difference to a successful programme delivery.
- If possible, co-design the programme with the intended recipients. If co-design is possible then the solutions have the best chance of being useful to the recipients and communities that receive them.
- The Sky Muster satellite service deployment programme has had unanticipated benefits for remote communities who are able to utilise broadband connections at community buildings outside of emergencies.
- Research in the context of Australia has shown there is a clear divide between rural and urban communities in being prepared for telecommunications outages. Rural communities have a greater understanding of and preparedness for telecommunications outages.

Case study: 'Better Connectivity Plan for Regional and Rural Australia': The Government of Australia announced the '[Better Connectivity Plan for Regional and Rural Australia](#)' in October 2022. The Plan includes AUD 100 million in funding for additional measures to strengthen telecommunications resilience against disasters. These measures include:

- Additional funding for further mobile network hardening, such as upgrades to back-up power capacity, transmission diversity, and the physical security of regional mobile network infrastructure;

- New funding for hardening broadcasting infrastructure against natural disasters, to improve the resilience of broadcasting tower sites and ensure that critical emergency information can be relayed to communities in a disaster; and
- Funding for a new 'Telecommunications Disaster Resilience Innovation¹⁶⁵' Programme, which will fund new, innovative solutions to address disaster resiliency challenges in line with a number of key themes, such as power resiliency, and making greater use of emerging technologies such as satellite, public Wi-Fi and hybrid power generators.

These initiatives will build on the successes of STAND and further improve the resilience of communications networks in Australia against the impacts of power outages and damage during natural disasters.

A1.3.3 Initiatives to improve telecommunications network resilience for disaster risk mitigation and management (Australia)¹⁶⁶

In 2022, the Australian Government announced the 'Better Connectivity Plan for Regional and Rural Australia', intended to improve connectivity in regional Australia, and targeting productivity, equity of services, and social and public safety outcomes. The Better Connectivity Plan includes AUD 656 million over five years to improve mobile and broadband connectivity and resilience in rural and regional Australia. This funding includes AUD 100 million for resilience development programmes, such as the **Mobile Network Hardening Programme Round 2** (Case study 1) and the **Telecommunications Disaster Resilience Innovation Programme** (Case study 2).

The Australian Bureau of Meteorology notes in its [State of the Climate 2022 Report](#) that climate of Australia has warmed by approximately 1.47°C in the period between 1910 and 2021, which is leading to more heat extremes and fewer cold extremes. It also notes the potential for an increase in the number of dangerous fire weather days, and a longer fire season for southern and eastern Australia¹⁶⁷. Additionally, the [September 2023 Climate Driver Update](#) forecasted warmer and drier conditions across most of Australia from October to November 2023. These findings highlight the importance of a proactive approach to supporting vulnerable and at-risk communities to meet the challenges of a warming climate. A resilient telecommunications network allows for continuity of service during and after a disaster, supporting emergency service responses and economic recovery. The following details two initiatives delivered by the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) that are designed to improve the resiliency of Australia's telecommunications infrastructure, and support vulnerable regional communities.

Case study 1: The Mobile Network Hardening Programme: The Mobile Network Hardening Programme (the Programme) was established in response to the 2019/2020 'Black Summer' bushfires in Australia. It provides grant funding for upgrades to mobile network telecommunications infrastructure in regional, rural and remote Australia to build resilience to, and support recovery from, natural disasters. Potential projects are identified by telecommunication industry applicants, based on type of infrastructure, location and threat from natural disaster. The Programme funds upgrades to mobile network telecommunications infrastructure to:

- prevent outages in the event of a natural disaster;

¹⁶⁵ <https://www.infrastructure.gov.au/media-communications-arts/phone/telecommunications-disaster-resilience-innovation-program>

¹⁶⁶ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0208/> from Australia.

¹⁶⁷ State of the Climate 2022, page 25.

- strengthen the resilience of telecommunications facilities to allow them to operate for longer during bushfires and other natural disasters; and
- enable the rapid restoration of services following an outage.

Resilience upgrades eligible for grant funding under the programme include:

- upgrading power capacity to a minimum of 12 hours at a telecommunications site;
- elevating infrastructure to protect it from floods;
- delivering emergency power solutions to rapidly restore services during or after a natural disaster;
- the installation of redundant backhaul; and
- expanding a protection zone around a site to increase protection from bushfires.

The first round of the Programme (Round 1) was delivered in two stages:

- Stage 1 provided AUD 13.2 million for upgraded battery backup power at 467 mobile base stations.
- Stage 2 provided AUD 10.9 million for 532 general resilience upgrades at mobile base station sites across Australia.
- 60 per cent of the 999 Round 1 projects have been completed (September 2023).

One example of a resilience improvement funded under Stage 2 is a fleet of 29 portable generators spread across depots in the state of New South Wales. This fleet, which is managed by a telecommunications provider, can be quickly deployed from a depot within a radius of 150 kilometres, as circumstances demand.

The second round of the Programme (Round 2) is intended to build upon the outcomes of Round 1. Round 2 is open to telecommunications industry applicants, with up to AUD 16.5 million available in grant funding. For applicants from the telecommunications industry, community input in the identification of suitable projects is facilitated by a 'noticeboard' on the [DITRDCA website](#). The noticeboard allows communities to identify potential areas of risk, or potential projects. In bringing the communications and telecommunications providers together, communities can inform projects included in the telecommunication industry members' applications for funding. Funding for the programme is assessed on a competitive basis according to guidelines developed by DITRDCA after robust public consultation.

Case study 2: Telecommunications Disaster Resilience Innovation Programme: The Telecommunications Disaster Resilience Innovation Programme (TDRI) provides AUD 50 million towards projects that improve the preparedness of telecommunications networks in Australia against rising climate risks, including against an anticipated increase in the frequency and severity of natural hazards in Australia. This is done by:

- supporting and accelerating the development and deployment of innovative, new or emerging technologies that will improve the resilience of telecommunications, particularly in rural, regional, remote or Australian indigenous persons (First Nations) communities;

- demonstrating the benefits of emerging telecommunications technologies in improving disaster resilience outcomes; and
- encouraging greater collaboration and partnerships between industry and government stakeholders on telecommunications disaster resilience matters.

The intended outcomes of the programme are:

- expedited adoption of emerging telecommunications technologies in Australia that will improve disaster resilience outcomes for Australian communities (including through preventing outages and/or supporting the rapid restoration of services following an outage); and
- reduced instances of telecommunications outages during natural disaster events, including reduced instances of communities being isolated and unable to contact emergency services or access other critical services/supports such as disaster financial assistance.

Two rounds are currently open to applications under the Telecommunications Disaster Resilience Innovation Programme: the 'Power Resilience Round', and the 'Innovation Round'.

Power Resilience Round: This round (AUD 30 million) will fund solutions that strengthen the resilience of telecommunications against the impacts of power outages. It concentrates on three focus areas:

1) Stand-alone, off-grid power solutions:

- Proposals that involve the development or deployment of innovative, place-based power solutions at existing telecommunications infrastructure sites or facilities that will remove (or substantially reduce) the exposure and dependence of these sites or facilities to the energy network/mains power supply.
- This may, for example, include stand-alone or hybrid power systems that combine a mix of renewable and non-renewable energy generation sources with energy storage to provide additional power resilience than could otherwise be provided by a standard battery or generator alone.

2) Deployable power solutions:

- The development or acquisition of new, innovative portable power solutions that can be rapidly deployed to restore power to at-risk telecommunications infrastructure sites or facilities following a disaster-induced disruption to the mains power supply.
- This may, for example, include solutions that provide a greater, longer lasting power supply, are more rapidly deployable, and/or are more readily able to access hard-to-reach telecommunications infrastructure sites or facilities relative to existing solutions.

3) Energy efficient telecommunications infrastructure:

- The development or deployment of innovative, place-based solutions that will reduce the energy consumption of telecommunications infrastructure sites or facilities, for the purpose of reducing power draw to increase the effective operational longevity of the backup power supply during natural disasters.

- This may, for example, include installing energy efficient equipment such as cooling and transmission equipment or other equipment, to optimise network load and reduce overall energy consumption in a natural disaster.

The Innovation Round: This round (AUD 20 million) will fund innovative technologies to improve the resiliency, redundancy, and availability of telecommunications during and after a natural disaster. The three focus areas targeted in the Innovation Round are:

1) Deployable telecommunications solutions:

- The development or acquisition of new, innovative and portable telecommunications facilities that can be rapidly deployed to restore connectivity for disaster-impacted communities.
- This may, for example, include new solutions that address or overcome existing barriers to deployment of portable telecommunications facilities such as by being more rapidly deployable and/or readily able to access hard-to-reach locations or offer greater coverage relative to existing solutions.

2) Satellite connectivity:

- The development or deployment of new or innovative satellite-based technologies, or using existing satellite technologies, such as geo-stationary satellites, in an innovative way, to provide critical telecommunications resilience and/or redundancy.
- This may, for example, include place-based solutions that involve the installation of long-range public Wi-Fi with satellite backhaul at emergency locations such as evacuation centres to provide additional redundancy, or portable solutions that make use of satellite connectivity for a similar purpose.

3) Enhanced situational awareness:

- This focus area is seeking to support projects aimed at improving situational awareness of telecommunications and power outages for emergency management purposes. These projects may involve improved monitoring, data collection and sharing between relevant entities to improve visibility of outages and restoration priorities.
- This may, for example, include the development of automated and real-time monitoring and reporting solutions to seamlessly collect and share outage data with relevant entities to inform emergency response and recovery efforts.

Conclusion: These initiatives will build on the successes of current programmes and further improve the resilience of communities in Australia against the impacts of power outages and damage during natural disasters. The Government is committed to developing a resilient telecommunications network. Feedback is sought through various channels, which allows for continuous improvement of these services, particularly as new technologies enter the market.

A1.3.4 Policy for emergency communication and equipment used in flood prevention and rescue (China)¹⁶⁸

Extreme natural disasters and their impacts: Many kinds of natural disasters occur in China, including floods, hailstorms, droughts, typhoons, earthquakes, geological disasters, low temperature freezing and snow disasters, sandstorms, forest and grassland fires, and marine disasters, etc. Disasters in 2021 and 2022, respectively affected 107 million and 112 million people respectively, resulting in direct economic losses of CYN 334.02 billion and CYN 238.65 billion^{169, 170}. Henan province in July of 2021, and Beijing and Hebei province in August of 2023, suffered extreme rainstorm disasters, which caused traffic, communications and power problems. These extreme conditions resulted in difficulties for the communications force to get into the disaster area. At the same time, poor natural conditions, large numbers of rescue teams, and intensive temporary public settlements meant that transferring information was difficult, communications among agencies were blocked, and communication requirements in some areas were suddenly increased.

Requirements for emergency communications are described as follows:

- Supervising risks and releasing early warning information, which are carried out before the disaster.
- Understanding how disasters impact command organizations and requesting rescue operations for the public.
- Emergency communications, including utilizing emergent mobile communication means to set up communication channels quickly.
- Supporting emergency response, including providing smooth communications for command organizations on site, emergency rescue teams, mass resettlement sites, and important agencies.

Policy for emergency communications. In China, the Ministry of Industry and Information Technology (MIIT) organized and coordinated China Telecom, China Mobile, China Unicom, China Satcom, China Tower, and other agencies to carry out communications support operations. There were a number of tasks to be carried out, and these included recovering public communications networks, and providing emergency communications in the event of a disaster. 32 national emergency communications teams with emergency communications equipment were created with the telecommunications enterprises. In recent years, the emergency communications ability of China has been enhanced by establishing special projects to enhance the level of emergency communication technology and equipment. This task was supported through the policy imposed by the fourteenth five-year plan for scientific and technological innovation in the field of public safety and disaster risk prevention and reduction¹⁷¹. Tasks included researching and developing equipment suitable for investigating disaster situations and decision-making, and of researching and developing integrated modular, lightweight, highly integrated, and easily built emergency communication technology equipment. Another task involved collecting and popularizing disaster response emergency communication technology and equipment. Solutions and advanced equipment for emergency communication were embraced, creating the necessary

¹⁶⁸ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0215/> from China.

¹⁶⁹ Basic situation of natural disasters in China in 2021 https://www.mem.gov.cn/xw/yjglbgzdt/202201/t20220123_407204.shtml.

¹⁷⁰ Basic situation of natural disasters in China in 2022 https://www.mem.gov.cn/xw/yjglbgzdt/202301/t20230113_440478.shtml.

¹⁷¹ The 14th five-year plan for scientific and technological innovation in the field of public safety and disaster risk prevention and reduction https://www.most.gov.cn/xxgk/xinxifenlei/fdzdgknr/fgzc/gfxwj/gfxwj2022/202211/t20221110_183375.html.

bridge between the supply side and demand side. By mobilizing social forces to solve key and difficult communications problems, and disseminating tasks among the various telecommunications agencies, national communications capabilities in extreme conditions were improved. A target of the initiative was to enhance the capability of collaboratively carrying out emergency communication support for flood prevention and disaster risk relief. To this end MIIT organized and stimulated cross-enterprise collaboration, which included sharing transfer lines among operators, recovering network connectivity based on regional divisions among operators, dispatching emergency communications teams and equipment across provinces, sending warning messages and safety tips to the public, providing mobile phone maintenance services, and delaying shutdowns due to arrears for the affected public.

Communication technology and equipment used. The following technology and equipment were used in flood prevention and disaster relief actions in recent years, and remarkable success were achieved. In the stage of reporting the disaster situation, and especially when the public network connectivity was down, Tiantong satellite mobile phones were used to call or send messages to the command centre. This helped the public to report the disaster situation and helped command to clarify the rescue goals. In the early stages of repair and recovery of the public network, UAV based mobile stations were used to cover the disaster areas from the air. During the rainstorm disaster in Henan in 2021, large fixed-wing UAVs equipped with mobile communication base stations and private network communication base stations, flew for 4.5 hours to the disaster area, and served customers in areas extending to 50 square kilometres. During the rainstorm disaster in Beijing and Hebei in 2023, middle hybrid-wing UAVs equipped with mobile communication base stations, took off vertically and hovered for eight hours at altitude, covering 30 square kilometre areas. In addition, portable backpack base stations were taken into the disaster site and activated, serving tens of customers. In the emergency response stage, portable satellite terminals worked with mobile communication base stations, and vehicle-borne emergency communication systems, and provided connectivity for large numbers of customers, including the public in settlement shelters, commanders, rescue teams, and vital agencies.

Measures for the future: Faced with the risk of increasingly frequent disasters brought about by global climate deterioration, the Government of China is promoting the following agenda to improve the resilience and rapid recovery ability of communication facilities.

- Revising and improving the technical requirements and constructional standards of communication infrastructures according to the disaster grade.
- Promoting operators to upgrade and co-construct mobile communications superstations by improving the disaster resistance level of communication rooms, increasing the means of transfer, and extending backup battery support time.
- Developing, equipping, and reserving more advanced communication equipment, and especially deploying satellite terminals independent of ground networks in areas prone to frequent disasters.
- Conducting skills competitions among emergency communications teams, and more frequent collaborative drills and exercises across enterprises and agencies, to promote the skills and collaborative capabilities to respond effectively to extreme disasters.

A1.3.5 Use of telecommunications for disaster risk reduction and management in the Democratic Republic of the Congo¹⁷²

Natural disasters such as floods, landslides, and volcanic eruptions exacerbate fragilities in the Democratic Republic of the Congo by degrading the already insufficient infrastructure and poor living conditions of the population. The events of recent years, caused by climatic hazards creating major floods and landslides, as well as the eruption of the Nyamulagira volcano, have resulted in significant loss of life and livelihoods. It is therefore imperative to limit the damage caused by such natural disasters by fully involving the local community in all disaster prevention processes. It is at this level that ICTs play an indispensable role in informing the public of the risks of impending disasters, before and during the disaster, and in enabling the continuation of economic and social activities after the disaster. Thus, in the interests of reducing the risk of natural disasters, the Democratic Republic of the Congo has set up:

- The Congolese Environment Agency (ACE), which is responsible for the environmental and social assessment of activities which may comprise environmental risks prior to the submission of a project, and for monitoring of their implementation.
- The National Disaster Risk Reduction Platform "PFN-RRC" is responsible for preventing new risks, reducing risks and finally managing residual risks.

Best practice: The use of ICTs is an effective tool for ensuring the transmission of information especially in times of crisis.

Overview of disasters in the Democratic Republic of the Congo: Natural disasters due to climate change and poorly planned urbanization have impacted a number of towns in the Democratic Republic of the Congo. Such natural disasters include river erosion and landslides in Bukavu, repetitive flooding in some parts of South Kivu, the volcano in North Kivu, earthquakes and house fires, resulting in loss of life and livelihoods. In the Democratic Republic of the Congo, floods have become common events in recent years, often resulting in landslides. Between 2020 and 2021, the country experienced 21 episodes of catastrophic flooding with severe consequences for the population and the economy. Poor urbanization, inadequate water drainage systems, and poorly constructed housing located on floodplains increase the country's vulnerability to climate-related shocks. Floods often spread diseases through contaminated drinking water and by creating mosquito breeding sites, which in turn lead to epidemic outbreaks of cholera and malaria. Floods also cause damage to already severely inadequate infrastructure and further increase the cost of transportation which accounts for 11 per cent of the consumer price index (CPI). Below is a list of just some of the disasters recorded from 2021 to date in the Democratic Republic of the Congo:

- In 2021, in the Kalehe territory of South Kivu, rivers flooding and exiting their beds, led to floods, mudslides and rockslides in a number of villages, causing 411 deaths, 54 people injured, over 3 000 houses and 6 schools destroyed, 30 unaccompanied children identified, and nearly 5 000 missing people.
- Also in 2021, the flank of Mount Nyiragongo erupted, causing lava flows towards Goma about 20 km south to Goma International Airport. This catastrophic eruption, similar to the eruption in 2002, led to 8 000 refugees in Rwanda, 15 people dead, 117 missing children; and 150 children separated from their families, as well as several hundred destroyed houses.

¹⁷² ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0198/> from Democratic Republic of the Congo.

- In 2023, at least 15 people died, as well as 2 missing, and 9 seriously injured while 5 houses were completely destroyed in the city of Bukavu as a result of a landslide caused by heavy rains and unplanned urbanization.
- Also in 2023, more than 300 people died, and nearly 4 500 people disappeared in the villages of Nyamukubi and Bushushu in South Kivu as a result of erosion.
- In February 2024, devastating floods impacted the Democratic Republic of the Congo by overflowing the Congo River to a level not seen in 60 years. More than 2 million people, 60 per cent of them children, are in need of humanitarian aid.

It should be noted that, almost every year, the Democratic Republic of the Congo experiences deaths, subsistence losses, infrastructure destruction, floods, landslides, erosions, and volcanic eruptions.

Government involvement in disaster risk management: The role of the Government of the Democratic Republic of the Congo in reducing and managing the risks of natural disasters is to establish a regulatory framework to enable the evaluation of the various projects or activities that may have an impact on the environment, and also to monitor their implementation. These include:

- Article 22 of Ordinance-Law No. 23/007 of 03/03/2023 amending and supplementing Law No. 11/009 of 09/07/2011 on fundamental principles relating to the protection of the environment stipulating that any project shall be certified after the assessment and approval of the environmental and social impact study, monitoring its implementation as well as environmental monitoring by the public establishment, – Congolese Environment Agency, ACE in acronym;
- Decree No. 14/019 of 02/08/2014 establishing the rules for the operation of environmental protection mechanisms as defined in Chapter 3 of the above-mentioned law;
- In accordance with ITU Resolution 71 on national disaster risk reduction strategies, SADC member countries have adopted a model of the national strategy for the implementation of a national emergency telecommunication plan in each State;
- The Democratic Republic of the Congo through the Ministry of PTNTIC and the regulator (ARPTC) is working on the road map for the implementation of the national emergency telecommunications plan based on the SADC national strategy model;
- From the use of ICTs in disaster risk management, the regulator "ARPTC" issues green numbers to the police and approves free promotional offers (voice, SMS and Data) to ensure the availability of communications during the mitigation, response and recovery phase of disaster risk management.

The Democratic Republic of the Congo perspective on disaster risk reduction and management: According to the IMF 2022 p4 report, the Democratic Republic of the Congo is the second most likely country to receive climate shocks and the eight most vulnerable country to the effects of climate change. Therefore, in view of the risks of disasters caused by heavy rains, poor urbanization, volcano eruptions, etc., the regulator (ARPTC) and the Ministry of Posts, Telecommunications, and New Information and Communication Technologies "PTNTIC" needs to put in place a plan to respond to these disaster risks, comprising:

- A multisectoral steering committee consisting of the regulator (ARPTC), ministries and other actors involved in disaster risk reduction and management;

- A national emergency telecommunications plan with accompanying measures;
- An alerting system including the Ministry of PTNTIC, the regulator (ARPTC) and other actors involved in disaster management;
- Green numbers that can be used make emergency calls in the event of a disaster;
- ARPTC should facilitate agreements that allow customers to use other people's networks in case of emergencies, ensuring that people can always communicate in the event of network disruption or overload during the period of risk;
- ARPTC should develop guidelines on the temporary location of antennas and faster approvals to replace sites damaged during crises; and
- Conduct a study to assess and analyse the contribution of ICTs in disaster management.

Conclusion: The use of ICTs is an effective and essential tool in reducing and managing the risks caused by natural disasters. Stakeholders in the digital ecosystem should ensure the availability of emergency telecommunications and support cooperation in this area, by implementing the strategy of the natural disaster risk response plan described above, in order to address all stages of disaster management, such as alerting, response, relief operations, and the updating of telecommunication networks before, during, and after disasters.

The purpose outlined here is to apply collaborative regulation with all institutions and agencies involved in the field of natural disasters.

A1.3.6 National emergency telecommunication plans: Catalysts and guarantees (Republic of the Congo)¹⁷³

The following are policy proposals that integrate the management of personal data into the use of ICTs for mitigating and managing disaster risks:

- **Protection of data and privacy:** Put in place strict rules to ensure that personal data collected as part of disaster management operations are protected against all forms of unauthorized access, disclosure and misuse.
- **Educated consent:** Ensure that citizens give educated and explicit consent for the collection and use of their personal data in disaster management, by providing them with clear information about how their data will be used and protected.
- **Data anonymization:** Promote the use of data anonymization techniques to minimize the risk of personal data disclosure while simultaneously enabling the authorities to access the data gathered so that they can make educated decisions on disaster management.
- **Limited retention period:** Limit the retention period for personal data collected as part of disaster management operations, and ensure that all such data are deleted or anonymized once no longer required for operational purposes.
- **Transparency and rendering of accounts:** Require full transparency regarding the manner in which personal data are collected, used and shared as part of disaster management

¹⁷³ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0145/> from Republic of the Congo.

activities, and require the rendering of accounts in the event of any violation of privacy or data security.

The following are examples of policy proposals that States and telecommunication regulators could consider adopting to facilitate the use of telecommunications/ICTs in disaster risk reduction and management:

- 1) Development of emergency and business continuity plans: Draw up detailed plans to ensure the continued availability of telecommunication services during disasters, including the allocation of additional resources and the adoption of rescue procedures.
- 2) Investment in resilient infrastructure: Encourage telecommunication operators to invest in robust infrastructure with built-in redundancy, such as disaster-resilient telecommunication towers and secure data centres.
- 3) Promotion of network interoperability: Develop rules and protocols allowing for efficient interoperability between telecommunication networks to facilitate communication and coordination between different government agencies and disaster relief organizations.
- 4) Use of emergency communication technologies: Encourage the adoption of technologies, such as SMS alerts, disaster warning applications for mobile telephones, survival radios and social networks, for disseminating key information and safety instructions to affected populations.
- 5) Training and awareness-raising: Put in place training programmes for telecommunication operators and local authorities on the use of communication technologies in the event of disaster, and conduct public awareness-raising campaigns to inform citizens about the methods of emergency communication available.
- 6) Regular tests and simulations: Hold regular simulation exercises involving telecommunication operators, government agencies and disaster relief organizations to evaluate the efficacy of emergency plans and identify areas for improvement.
- 7) Integration of ICTs in disaster management systems: Use ICTs to improve the collection, analysis, and dissemination of disaster-related data to support educated real-time decision-making.
- 8) International coordination: Reinforce international cooperation and coordination in the area of disaster management by exchanging best practices, information, and resources with other countries and with international organizations.
- 9) Put in place strict rules to ensure that personal data collected as part of disaster management operations are protected against all forms of unauthorized access, disclosure, and misuse.
- 10) Data anonymization: Promote the use of data anonymization techniques to minimize the risk of personal data disclosure while simultaneously enabling the authorities to access the data gathered so that they can make educated decisions on disaster management.

These policies are designed to enhance the resilience of telecommunications infrastructure and improve the ability of governments and populations to cope with disasters through the efficient use of ICTs.

A1.3.7 Predictive and proactive approach for efficient preparedness and response to disasters and developing resilience of telecommunication infrastructure (India)¹⁷⁴

Background. Telecommunications play a very important role during disasters, starting from the alerting of populations likely to be affected prior to a disaster, through to rescue and relief activities post disaster. India has shifted its approach to dealing with the disasters, from reactive to predictive. In recent times, the Government of India through the Department of Telecommunications, has proactively played a role both prior to, and during disasters to support relief activities pre- and post-disaster. Proactive disaster preparation and effective disaster response strategies were showcased during a number of major disasters over the last decade, such as Cyclone Fani (April, 2019), Amphan (May, 2020), Tauktae (May, 2021), Cyclone Biparjoy (June, 2023), and Michaung (December, 2023), etc.

Enabling policy and regulatory environment

- The Government of India has setup an institutional framework for ensuring a proactive approach towards disaster management, and to ensure a collaborative approach among different Government departments at both local and State level. The National Executive Committee (NEC) was created, and is responsible for the coordination and monitoring of the disaster management process. In addition to the Union Home Secretary, members of the committee include a Secretary from each of the Ministries and Departments with responsibility for agriculture, atomic energy, defence, drinking water, environment and forests, finance (expenditure), health, power and rural development, science and technology, space, telecommunications, urban development, water resources, and the Chief of the Integrated Defence Staff.
- The National Telecom Disaster Co-ordination Committee (NTDCC) and the Digital Communication Commission were created in 2017, and members include telecommunication service providers, and officials from the Ministry of Home Affairs and the National Disaster Management Authority.
- Collaborative partnerships were established in all States. The State Telecom Disaster Coordination Committee (STDCC) was constituted in 2017, and in all the States comprises officials of the Department of Telecommunications (DoT) and of State Government to ensure better coordination pre-disaster and post disaster.
- Collaborative partnerships with various agencies, power distribution companies, and port authorities were established. Field war rooms and restoration teams were formed in each district, along with implementation of the intra circle roaming (ICR) system, ensuring uninterrupted communication. ICR provides connectivity to the public through latching onto the best signal available of any telecommunications service provider (TSP), even if the signal of an individual's telecommunications service provider is not available.
- To enable ICR during a disaster all TSPs have guaranteed roaming arrangements and there is a memorandum of understanding (MoU) among the TSPs to facilitate roaming within the 'State/Circle' during disaster events. Orders are issued by Government, to enable roaming for certain number of days and to ensure the continuity of telecommunication services during disasters.

¹⁷⁴ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0208/> from India.

- In the response and recovery phase, real-time assessments, and coordination with local authorities and the National Disaster Response Force (NDRF) facilitated prompt repairs. Critical success factors included early alerts, ICR implementation, coordinated efforts with the State Government, and an effective EWS (EWS). Challenges, such as restoring power supply amid logistical difficulties, were addressed through a comprehensive approach.
- Standard operating procedures (SOP) outlining actions for all six elements of disaster management (prevention, mitigation, preparedness, response, rehabilitation, and reconstruction) have been issued. The following is the link of SOP issued by the Department of Telecommunication (DoT): (https://dot.gov.in/sites/default/files/2021_01_06%20SOP-2020%20DM.pdf?download=1)
- Field war rooms and restoration teams were formed in each district. In the response and recovery phase, real-time assessments and coordination with local authorities and the National Disaster Response Force (NDRF) facilitated prompt repairs of telecommunications infrastructure.

Recent success stories

- The swift and effective response to the Silkyara Tunnel collapse demonstrated a successful coordination with telecommunications service providers (TSPs) to enhance network connectivity through the deployment of 'small cells', that ensure communication in challenging environments. A telephone exchange was established at the site and a line was extended inside the tunnel, through which trapped workers could communicate with their relatives. Despite encountering difficulties, cell sites were installed at 'Hill Top' and provided connectivity to the various agencies involved in rescue operations.
- In October 2023, a lake burst resulted in extensive damage to the telecommunications network in Sikkim. The 'cell on wheels' (CoWs) system was mobilized, and intra-circle roaming was activated immediately. In addition, very small aperture terminals (VSAT) terminals were mobilized to provide immediate connectivity in the areas where the terrestrial network was down due to a fibre-optic cable cut.
- During sudden floods in Himachal Pradesh, major routes to a number of districts were flooded and the fibre-optic network of almost all TSPs was down in the districts of Kullu and Manali. Intra-circle roaming (ICR) was activated immediately to support the general public, relief and rescue operations, and restoration activities. Taking stock of the situation, large-scale restoration was initiated to restore telecommunications connectivity. A communication group was formed in which officials of licensed service areas (LSAs), TSPs, State Government, NDMA were present. Drones were also used to restore fibre-optic connectivity where roads were damaged.
- Coordinated and special efforts have been made to ensure the continuity of telecommunication services and the maintenance of additional load during a number of train accidents in the remote locations.

Success story of the recent Cyclone "Biparjoy" June 2023

- During Cyclone Biparjoy, a proactive approach was adopted to predict the impact of the cyclone on telecommunication services in selected districts of Gujarat. In anticipation, intra circle roaming (ICR) was activated based on the predicted path of the cyclone.
- Preparations encompassed early alerts, meetings, and the establishment of a communication group for coordinated efforts. Collaborative partnerships were forged with telecommunications service providers (TSPs), district management, and power distribution companies.
- The support extended by the State Government, coupled with leadership from licensed service areas (LSAs), significantly fortified overall response efforts. Mobile network availability was sustained for both disaster response agencies (DRAs) and the public during Cyclone Biparjoy.
- Gujarat LSA played a proactive role in fostering collaboration and coordination with District Management officials. This included facilitating the smooth movement of TSPs and arranging for fuel supplies in case of power failures. Coordination with the Gujarat State Disaster Management Authority and other state government authorities, including power distribution companies, ensured priority power supply restoration at critical sites for TSPs.
- Meetings were conducted with State authorities, and direct communication was established with the managing director of PGVCL, a power distribution company, in order to fully convey the gravity of the situation and so obtain the necessary support.
- Gujarat LSA maintained coordination with government agencies responsible for disaster response, ensuring seamless information sharing and mutual support during and after the cyclone. The proactive measures and collaborative efforts undertaken by the authorities were crucial in mitigating the impact of Cyclone Biparjoy and ensuring the uninterrupted functioning of telecommunication services.
- The efforts of the Department of Telecommunications (DoT) and telecommunication service providers (TSPs) were appreciated by the State Government of Gujarat.

Conclusion: Previously, the focus was primarily on response and rehabilitation post-disaster, however a significant paradigm shift has occurred with India now channelling its efforts towards mainstreaming disaster management of telecommunication infrastructure. This shift includes the adoption of a proactive, predictive approach to ensure the continuity of telecommunication services for both rescue and relief forces, and the general population. This strategic shift has led to a more effective handling of disasters, contributing to the preservation of lives.

During Cyclone "Biparjoy", despite the fact that it was of great intensity and lasted for two days even after landfall, zero casualties were reported, and the telecommunications network was restored within in a short span of time. Key factors in managing the cyclone efficiently included:

- Sensitizing field units beforehand.
- Activation of roaming among telecommunications service providers (TSPs) beforehand, ensuring continuous telecommunications coverage despite network disruptions.
- Timely and targeted early warning messages to keep the public informed and prepared.

- The State Telecom Unit of the Department of Telecommunications, led in active collaboration and coordination with State Government and district officials.
- Identification of district nodal officials from various agencies, ensured a seamless coordination in disaster response efforts.
- Proactive support was provided by the State Government in facilitating the activities of TSPs, arranging fuel supplies, and prioritizing power restoration at critical sites.

A1.3.8 Enhancing regulatory and licensing policy to ensure resilience through telecommunications and ICTs in disaster prone areas (Brazil)¹⁷⁵

Statement of the situation or problem: In the face of natural and man-made disasters, terrestrial communications networks are often severely damaged and their services disrupted. Land-lines, mobile towers and antennas are often destroyed and cannot be used for emergency services. Satellite networks, being unaffected by conditions on the ground, have the capability of restoring connectivity in an immediate manner wherever the need arises, and thus play an essential role in disaster response. Satellite communications rely on limited ground-based communications systems and are therefore almost independent of terrestrial infrastructure. Their global coverage can ensure full network functionality, performance, and service within the entire area affected by a natural disaster, whatever the scale, increasing the effectiveness of emergency services. The rapid deployment of satellite networks is an additional key factor that enables the restoration of communications within record time. Another important feature of satellite systems that contributes to resilience, is their redundancy. Satellite networks can comprise overlapping coverage so that if one satellite fails, another can takeover. For example, multi-orbit solutions allow low Earth orbit (LEO), medium Earth orbit (MEO), and geostationary Earth orbit (GEO) satellites to combine their respective strengths and so increase the capacity, reliability and speed of the satellite network.

Satellite broadband networks are not susceptible to damage from disasters, because the primary repeaters are on spacecraft and not part of the ground infrastructure. Hand-held terminals, portable very small aperture terminal (VSAT) antennas, and temporary fixed installations can all be introduced into a post-disaster environment to provide support to relief and recovery efforts. For example, satellite telecommunications equipment was deployed very quickly, due to relaxations in type approval and marketing access licensing, in Republic of Mozambique and Republic of Zimbabwe after the severe devastation caused by Hurricane Ida in 2019. The hurricane hit Mozambique, and the city of Beira, before striking Zimbabwe and Malawi. Hurricane Ida caused devastating floods, killed or injured thousands of people, and damaged crops, houses and roads. Over 2.6 million people were affected across the three countries, with most of the districts being almost completely cut off. All terrestrial communications infrastructure was destroyed. Satellite telecommunications equipment was sent to the devastated areas where telecommunications were most needed for the coordination of response efforts on the ground. By harnessing such technological advancements, disaster prone countries can bolster their preparedness, response, and recovery efforts. Resilient communication infrastructure, including satellite networks, ensures continuous connectivity during emergencies, facilitating coordinated response efforts. Strengthening the capacity of local institutions through training programmes, and fostering partnerships with regional stakeholders further enhances disaster resilience. By integrating telecommunications/ICTs into comprehensive disaster management strategies, disaster prone countries can better protect infrastructure and livelihoods from the impacts of natural disasters.

Analysing national experiences and best practices. Regulators should take into account the general objectives of their telecommunications regulatory framework which will always include "connectivity and emergency assistance." Policy needs to be developed that encourages investment in infrastructure

¹⁷⁵ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0361/> from Intelsat US LLC, Brazil.

and the promotion of innovation and of regulatory predictability in times of disasters and emergencies. Major steps are as follows:

- Abolish satellite landing rights in times of emergencies. This means that an authorized satellite Earth station network operator can deploy space segment services without restrictions as to where that supplier might be authorized or licensed.
- Make changes to the way authorizing the provision of communication networks and services, during times of disaster or emergencies, is carried out. This allows authorization requirements for individual licences to be waived in order to obtain a general temporary authorization by notifying the authorities.
- Provide clear conditions for type approval of radio equipment, and its market placement, in order to facilitate quick access to markets in times of emergencies and natural disasters. This would enable predictability of the application review timeframe, and so help operators plan for deployment (adoption of a default approval of the application if the regulator does not respond within certain timeframe, could be considered).
- Ease the processes of doing business. The licensing and authorization processes could be streamlined and simplified, and where possible provide a single window for the licence application and the entire set of approvals requirements.
- Enable an online licence application process. Allow online licence applications, this will ease the workload, provide easy tracking, and save time.

Desired outcome: A multi-faceted approach is required for enhancing disaster resilience in disaster prone regions through telecommunications and ICTs. By leveraging both terrestrial and satellite technologies, countries can overcome the vulnerabilities of traditional infrastructure, and ensure continuous communication during emergencies. The aim of this multi-faceted approach is to embrace equipment blanket licensing, and where possible, exemptions from licensing and free circulation in times of emergency, and also remove the need of service licensing to embrace "registration" and so reduce costs to end users. As new satellite systems begin to provide service, blanket licensing also allows for scaled solutions that should aim to streamline licensing of satellite Earth stations as much as possible.

A1.3.9 Using telecommunication/ICT to reduce and manage disaster risks (Burundi)¹⁷⁶

As science and technology are increasingly being applied to reduce uncertainty regarding health and environmental risks, ICTs have come to be used in disaster risk management primarily before, during and after events. Today, ICTs play a significant role in communications both by helping to prevent dangers and also by facilitating requests for assistance in the event of a disaster risk linked to climate change.

History of disaster risks in Burundi between 2014 and 2021: Burundi is no stranger to the effects of climate change, having experienced a lasting drought in the northern and central provinces, widespread desertification following environmental degradation (caused by deforestation and a population explosion), riverbank erosion in Bujumbura, repeated flooding in some areas, landslides, earthquakes, forest fires (also affecting residential and other infrastructure), and epidemics. On the night of 9 January 2014, floods which occurred to the north of Bujumbura, in the Gatunguru district resulted in a number of fatalities, with 182 people injured, 1 100 homes destroyed and a further 900

¹⁷⁶ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0029/> from Burundi.

homes damaged. On 20 December 2019, in Uwinterekwa, the Cari and Nyabagere rivers broke their banks, and the resultant flooding caused considerable damage, including deaths, injuries and the destruction of homes. The same area was again hit by flooding in March 2020.

Role of stakeholders in disaster risk management. The Government of Burundi assists in the coordination and implementation of material support, including the provision of food, medicines, and drinking water. Burundi Red Cross has launched and implemented programmes aimed of preventing and alleviating suffering in communities throughout the country. The organization uses the "model household" approach to community development, in which emergency care is one of the pillars that contributes to the transformation and changing of household behaviour. The Ministry of Solidarity, Social Affairs, Human Rights and Gender, oversees the distribution of food and other forms of support.

Other State actors and non-governmental organizations, such as the World Food Programme, the International Organization for Migration, the United Nations Children's Fund, etc., have made significant contributions to support disaster-related risk management. ICTs are the primary means of communication, making use of, among other things, mobile telephony, the Internet, social networks such as WhatsApp and Viber, Freephone numbers, and radio broadcasts, in addition to weather reports broadcast on television.

Study findings. The findings of the study are as follows:

- The integration of ICTs into disaster risk management in Burundi has two main benefits: it facilitates a speedier response through the use of EWSs at each stage of crisis management (communications, decision-making, resource dispatch), while at the same time minimizing damage (human and material), saving as many lives as possible, and making it easier for victims to call for help. Thanks to ICTs, information can be communicated rapidly, and responders can ensure that they are prepared to act immediately when required.
- ICTs enable victims to request help from various services.
- ICTs enable individuals to use social networks to share information with public and private media, thereby facilitating rescue operations.
- Lastly, the use of numbering resources (freephone numbers) and emergency call centres to request emergency assistance from the police, the Red Cross, or the local authorities helps to limit the damage caused as much as possible.

Conclusion: When used correctly to share information, ICTs can help reduce the risks and impact of natural disasters. While challenges remain, ICTs are an essential tool for improving the efficiency of disaster and climate change management.

A1.3.10 Action plan for COVID-19 including cooperation with related organizations (Senegal)¹⁷⁷

DAANCOVID 19: a citizens' initiative that puts digital at the heart of the fight against the pandemic

When the first case of COVID-19 appeared in Senegal on 2 March 2020, the President of the Republic assessed the potentially disastrous consequences of the virus and adopted strong measures to protect citizens and limit the spread of the disease in Senegal. The population was committed behind the Head of State to participate in the response against COVID-19. Beyond the immediate health emergency, COVID-19 was having a negative impact on people. In this context, digital technology, the main

¹⁷⁷ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0053/> from Senegal.

growth lever for the national economy, and the third presidential initiative of the 5-3-5 five-year programme, played a key role in managing the crisis. The private sector led by the Organisation of Information and Communication Technology Professionals (OPTIC), and the Ministry of Digital Economy and Telecommunications, jointly implemented a digital response plan, called DAANCOVID 19, to support the Ministry of Health and Social Welfare in its fight against the COVID-19 outbreak. Under the co-chairmanship of the Ministry of Health and Social Welfare (MSAS), the Ministry of Digital Economy and Telecommunications, and the DAANCOVID 19 citizens' initiatives committee, the project supported any digital solution that would enable efficient and effective management of the fight against COVID-19. The Senegalese private sector formed part of the national solidarity movement to support the actions of the President of the Republic in the fight against the COVID-19 pandemic, and also in the accompanying measures to support the economy.

The aim of DAANCOVID 19, which brought together the best digital resources in the country on a voluntary basis, was to contain the COVID-19 pandemic in Senegal through the employment of digital technology. The initiative was organized around five sub-committees, which were coordinated by a technical committee, which in turn was led by a steering committee. These sub-committees, led by working groups, were composed of experts from various companies and industry sectors, working in unison, and applying their expertise to achieve the following:

- **Communications:** to ensure continuous, engaging, reliable and proactive communication with the public, the medical profession, patients and the DAANCOVID 19 team;
- **Management, steering, and decision support:** to ensure optimal management of patients and medical resources;
- **Analysis, follow-up, and research:** to provide information for decision-making and prediction in the case management;
- **Legal expertise:** to ensure legal compliance with regard to processing, and declaration of data and information;
- **Digital solutions:** to federate, pool, organize and standardize the most relevant digital solutions in the fight against COVID-19.

To achieve the ambitious goal of "zero cases of COVID-19 in Senegal", an action plan composed of six key points representing the major issues defined in collaboration with the Ministries of Digital Economy and Telecommunications and that of Health and Social Action, was implemented:

- **Inform,** by sensitizing the population through all possible digital channels;
- **Manage and optimize,** making optimal use of the country's health resources;
- **Be proactive,** anticipate the control of the spread of the COVID-19 pandemic;
- **Harmonize and rationalize** by centrally controlling the digital response in order to make it more effective;
- **Respect the laws and regulations** concerning personal data and digital sovereignty;
- **Address non-health aspects.**

After almost three months of activities, DAANCOVID 19 had presented a very satisfactory first assessment with a number of major achievements, and concrete results:

- The establishment of a single, free 1919 number for the rapid handling of calls by the alert unit.
- The reinforcement of awareness through massive use of digital messaging through all information channels.
- Management and optimization of health resources through the deployment of applications that automate the management of healthcare records, stocks of personal protective equipment (PPE) products, etc.
- The deployment of tools to help control the spread of the pandemic through the implementation of advanced analysis solutions such as a consumer mobile application.

The initiative counted more than 450 active professional volunteers, from Senegal and elsewhere, engaged 24/7 in the fight against COVID-19, the common enemy.

Other digital platforms to fight or mitigate the COVID-19 pandemic:

- The establishment of the official website (<https://vaccinocorona.sec.gouv.sn>) of the Republic of Senegal, which enables taking a number of steps online regarding the COVID-19 vaccine: Citizens can apply for a vaccination certificate, register to be vaccinated, or request a conversion from the old vaccination certificate to the new Smart Health Card (SHC) certificate.
- The establishment of a platform called "Together against COVID-19" to provide answers to citizens' questions about the COVID-19 coronavirus.
- The diaspora registration support platform, called "FORCE COVID-19 - DIASPORA", this digital system complements the previous paper system which remains valid. The service is accessible on any type of terminal through a browser. It has been designed for ease of use by people with disabilities.

A1.3.11 COVID-19 Response Plan in Côte d'Ivoire (Côte d'Ivoire)¹⁷⁸

The first case of COVID-19 was detected in Côte d'Ivoire on 11 March, 2020, but the Government had already convened a crisis committee to manage the risk of contagion and the spread of the disease. The Ministry of Health and Public Hygiene set up a vast programme called the **"COVID-19 RESPONSE PLAN"** encompassing all aspects for limiting the spread of the disease, ranging from prevention, and medical care to post-medical follow-up.

A1.3.11.1 Elements of the National Response Plan

The implementation of this programme was, among other things, focused on a major media campaign, and screening for COVID-19. These two actions were based on the use of digital content, and the means of communications used by populations, health professionals, and parties involved in the fight against the pandemic.

The awareness campaign: An awareness campaign consisting of advertising inserts but also of digital communications was initiated. Social networks and a number of websites disseminated information about the COVID-19 pandemic. The government information and COVID-19 prevention website <http://>

¹⁷⁸ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0116/> from Côte d'Ivoire.

info-covid19.gouv.ci/ provided real-time information such as the number of new cases, recoveries and deaths, government news updates during the crisis, and global statistics on the pandemic, etc.

Figure A-25: Information website for COVID-19



Awareness was also raised through television and radio broadcasting, which was used because it remains more accessible to populations in the country. The awareness campaign aimed to inform people about the best actions to take, the symptoms of the disease, the locations of screening centres, and also the commissioned toll-free contact numbers to call in case of suspicion of infection.

The toll-free numbers: Toll-free numbers 101, 125, and 143 were made available to the public for COVID-19 pandemic-related information and rapid support. The same was also true for the numbers 113 and 1366, which could only be used for short messages (SMS) but which, on the other hand, incurred some costs.

All these toll-free numbers were made accessible regardless of the network of the national telecommunications operator used.

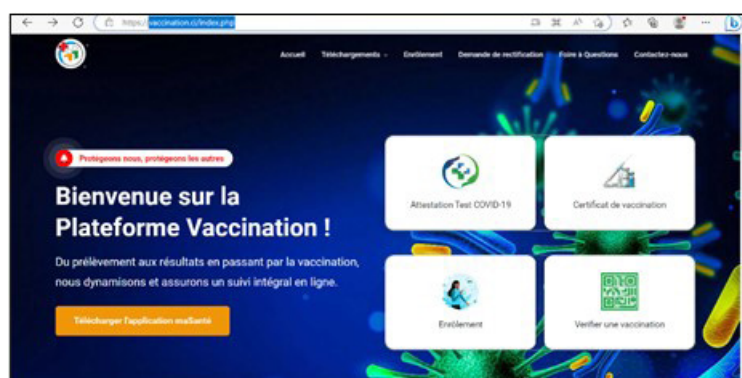
The use of digital tablets by health workers for COVID-19 screening: The COVID-19 screening teams of the National Institute of Public Hygiene (INHP) were made up of teams based in screening centres, and of others belonging to mobile units that could go directly to individuals to perform nasopharyngeal swabs. In terms of logistics, the entire district of Abidjan, and the towns throughout the country, had screening centres and medical treatment cells. These amounted to 14 screening and collection centres and sites, 116 rapid intervention teams (RRT) carrying out nasopharyngeal swabs, and approximately 6 000 teams of 5 people (30 000 people) forming mobile units. All of these resources were equipped with connected tablets for recording the data collected.

The digital tablets were connected either to the Wi-Fi of the screening centre or medical centre, or using to pocket Wi-Fi obtained from the mobile telecommunications operators. In addition, the application used by the tablets to collect digital data was set up by the Ministry of Health and Public Hygiene.

All collected information was transmitted to a data centre for processing. Data processing was entrusted to SAH Analytics International, an external service provider acting under the supervision of the State (Prime Minister's office and Ministry of Health). It should also be noted that this structure had its own cloud, thus guaranteeing the protection and confidentiality of the personal data of all persons sampled.

The MA SANTÉ.CI website and application

Figure A-26: Website of MA SANTÉ.CI



The website <https://vaccination.ci/index.php>, is quite complete and gives access to several platforms allowing the results of the COVID-19 tests, the vaccination certificate, the follow-up of the vaccination process, as well as the verification of the validity of a vaccination to be obtained. In addition, there is the "MASANTE.CI" (MY HEALTH) application which has the same functionalities as the website, and which can also be downloaded on the mobile phone. Access to this platform is only possible from a code communicated to the person during the COVID-19 screening or vaccination process.

A1.3.11.2 A practical case: COVID-19 screening

The physical screening: The Pasteur Institute of Côte d'Ivoire (IPCI) operates as the reference laboratory. All nasopharyngeal samples taken by the National Institute of Public Hygiene (INHP), and all samples taken in the screening centres were sent to the Pasteur Institute. From 2020 to 2022, approximately 2 000 000 tests were carried out with processing times of 48 to 72 hours. Apart from the sampling and laboratory analysis which are done physically, the rest of the process, from registration, to the transmission of the results of the people tested, can be carried out by means of ICTs (online or on personal mobile phones).

The process until the results are obtained: Conveniently, nasopharyngeal samples could be taken anywhere in the territory, and the data was then instantly recorded in the system using a connected tablet, which generated an enrolment code at the end of the enrolment process. This code was noted on the sample, along with the patient's name. From this moment, a health worker with a batch of pre-printed neutral codes in the form of "QR codes", and an encrypted (8 to 10 digits) code, matches the patient's data to one of these codes, which then becomes the code of the person tested, and this code is physically given to him in the form of a sticker. The process is the same for the mobile units that come directly to people's homes to take samples.

Figure A-27: Screenshot of a sticker



The sticker comprises the encrypted QR code, so that the person tested can consult his results on the platform <https://attestationcovid.ci/code-patient> of the website <https://vaccination.ci/index.php> and scan or print the test result. The person tested can also check the test result on his/her smartphone using the MA SANTÉ.ci application.

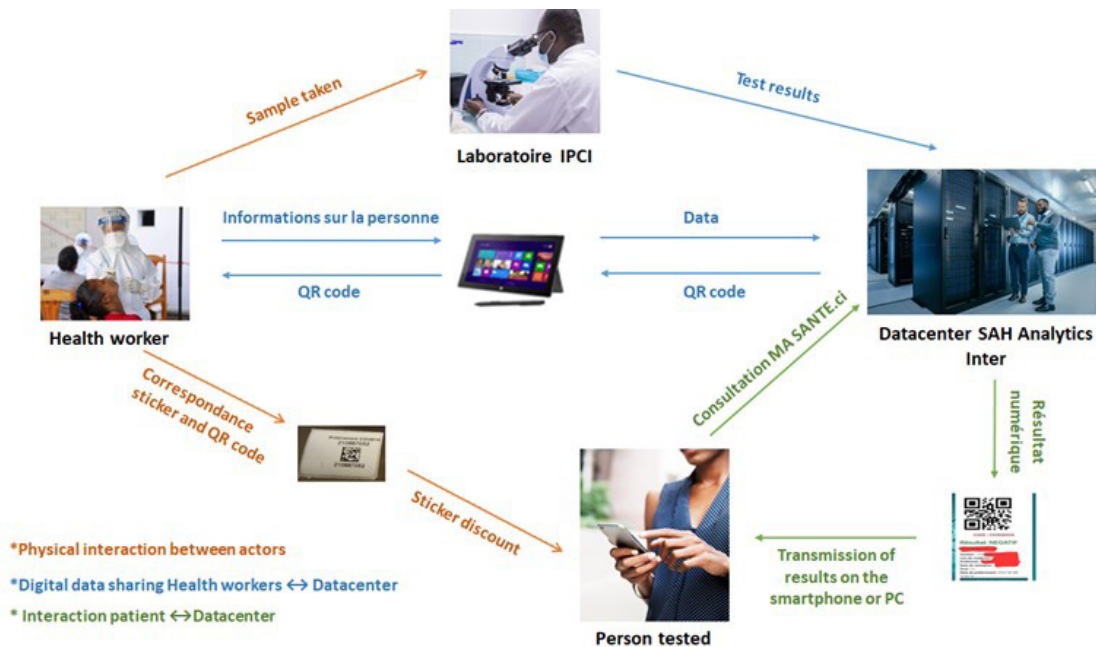
Figure A-28: Screenshot of a test result



The person tested also receives on their communicated mobile number, an SMS informing them when the results of the COVID-19 test are available.

Conclusion: The use of telecommunications/ICTs for disaster risk mitigation and management played a significant role in helping people to avoid risk of exposure to contagion through otherwise repeated physical attendances at COVID-19 testing centres and health centres. Such initiatives could serve as a textbook case for the management of other types of disasters. However, such initiatives require good coverage and easy access to telecommunications services.

Figure A-29: Scheme of the process



A1.3.12 Single emergency number 112 (Romania)¹⁷⁹

112 is the European emergency number, available free of charge, 24/7, anywhere in the European Union. Citizens can dial 112 to reach emergency services, including the police, emergency medical services, and the fire brigade. While you can still use your country's individual emergency numbers, 112 works in all European Union Member States, as well as in Republic of Albania, Georgia, Republic of Moldova, Iceland, Republic of North Macedonia, Montenegro, Principality of Liechtenstein, Norway, Republic of Serbia, Confederation of Switzerland, Türkiye, and the United Kingdom. 112 became the single European emergency number in 1991¹⁸⁰. The European Electronic Communications Code ensures that in Europe, you can contact 112 from any phone, wherever you are, for free. In Romania, two decades ago, 112 replaced the individual numbers 955, 961, and 981 that could be called to reach the specialized response agencies, contributing to the efficient, coordinated, and collaborative management of dangerous situations nationwide and saving lives. 112 has been for 20 years the single emergency number in Romania, during which time over 300 million calls have been handled by the Special Telecommunications Service (STS) call-takers. Since 2004, the 'Single National Emergency Call System' has proved to be a simple, efficient, and fast method for alerting the emergency services. 112 is now the unique number for emergency calls, which can be called from all public telephone networks in Romania. Calls are answered 24/7 by operators and, depending on the type of emergency, callers are then transferred to specialist response agency dispatchers, who conduct a competency-based interview, and assign and alert responders. Calls can be answered and handled in several international and national minority languages.

Legal framework and the functioning of the 112 emergency service in Romania: The establishment of the 112 system in Romania involved developing normative acts¹⁸¹ and inclusion in government strategies and policies. The system introduced the single emergency number 112 across public fixed and mobile networks¹⁸². The Ministry of Research, Innovation and Digitalization oversees its coordination, while the Special Telecommunications Service (STS) manages its operation and maintenance. The Romania National Authority for Management and Regulation in Communications (ANCOM), establishes obligations for fixed and mobile operators and assesses contraventions. According to data provided by the Special Telecommunications Service (STS)¹⁸³, from 2004 until the present day, the percentage of non-emergency calls has dropped from over 90 per cent to under 50 per cent. By integrating new technologies and standards, including advanced location methods, the

¹⁷⁹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0321/> from Romania.

¹⁸⁰ Additionally, European Union legislation (the 2018 European Electronic Communications Code, 2019 Accessibility Act) requires equivalent access to emergency services for people with disabilities. Several solutions are currently in use in different European countries, including total conversation, relay services, SMS, Real-time Text (RTT), smartphone applications etc.

¹⁸¹ Law no.398 of June 14, 2002, for the approval of the Romanian Government Ordinance no.18/2002 on the functioning of the Single National Emergency Call System (SNUAU); Romanian Government Decision no. 227/2003 on the approval of the conditions for the installation, operation, maintenance of the Single National System for Emergency Calls (SNUAU), as well as for the establishment of an activity besides the Special Telecommunications Service, financed entirely from own revenues. Romanian Government Ordinance no. 81 of July 14, 2005, for the amendment of para. (2) of art. 7 of Government Ordinance no. 18/2002 on the functioning of the Single National System for Emergency Calls; Romanian Government Decision no. 1.118 of 22 September 2005 on the designation of the specialized structures of the Romanian Gendarmerie and of the specialized unit of the Romanian Information Service as specialized intervention services; Order on the implementation of the Single National System for Emergency Calls, no. 112/07.04.2005 (Official Gazette of Romania, Part I, No. 312/13.04.2005).

¹⁸² There are four location methods implemented in Romania (AML, APEL 112 mobile application, Geolocation and Cell ID/Sector ID) all of which are complementary to each other, but none of them is infallible. For this reason, when a user calls 112, he must provide as many details as possible regarding the emergency location. Cooperation with the STS operator and emergency agency dispatchers is especially important to determine the place where intervention is required. <https://sts.ro/en/noi-reglementari-pentru-imbunatatirea-localizarii-apelurilor-la-112/>.

¹⁸³ 112, 20 years in Romania, February 11, 2024, <https://sts.ro/ro/112-de-20-de-ani-in-romania/>.

112 system in Romania has become a model of best practices for other European countries. In 2023, of the 10 489 979 calls to 112, 53.82 per cent were emergencies, while 46.18 per cent did not require intervention from emergency agencies such as the ambulance service, police, Emergency Situations Inspectorate (ISU-SMURD), or the Gendarmerie¹⁸⁴.

Table A-4: Statistics of 112 calls

Statistics regarding 112 calls in Romania ¹⁸⁵			
Year	Total number of calls	Emergency calls	Non-emergency calls ¹⁸⁶ (Calls that did not require the intervention of agencies such as Ambulance, Police, Emergency Situations Inspectorate (SMURD))
2023	10 489 979	53.82 per cent	46.18 per cent
2022	10 248 377	57.82 per cent	42.18 per cent
2021	10 337 426	59.27 per cent	40.73 per cent

Most calls were forwarded to ambulance services (49.29 per cent), with police (24.01 per cent) and Emergency Situations Inspectorate ISU-SMURD (18.76 per cent) also receiving significant portions. The distribution of calls, by responsible institutions, including other response agencies involved in managing such cases, is presented in Table A-5:

Table A-5: Distribution of 112 calls

The distribution of 112 calls in Romania according to the responsible institutions ¹⁸⁷	
Specialized response agencies	Transferred calls percentage
Ambulance	49.29 per cent
Police	24.01 per cent
ISU-SMURD (Emergency Situations Inspectorate)	18.76 per cent
Gendarmerie	5.85 per cent
Other agencies	2.10 per cent

The Call 112 app, available for free, automatically transmits a caller's location to the 112 system. If offline, users can manually provide their coordinates. Another solution, Geolocation 112, involves receiving an SMS link to send location coordinates to the system. Most of the calls under the responsibility of the 112 service, received throughout last year, were forwarded to the ambulance service.

New innovative tools for 112 caller location identification in Romania: In Romania, 112 call location information is currently determined through radio cell coverage and, where possible, global navigation satellite system (GNSS) functionality on smartphones. Cell-ID based location data is available for most calls but is often imprecise, covering large areas, while advanced mobile location (AML) is used for about half of the calls to improve accuracy, depending on the handset and technology. In 2023, the

¹⁸⁴ 112, for 20 years in Romania, February 11, 2024, <https://sts.ro/en/112-de-20-de-ani-in-romania/>.

¹⁸⁵ Official data taken from the Special Telecommunications Service (STS) in Romania.

¹⁸⁶ In Romania, falsely informing the authorities is punishable by the legislation in force (OG 34/2008) by imposing fines between 400 EUR and 800 EUR, or by performing 200 to 400 hours of community service.

¹⁸⁷ 112, for 20 years in Romania, February 11, 2024, <https://sts.ro/en/112-de-20-de-ani-in-romania/>.

Government of Romania introduced an emergency ordinance¹⁸⁸ to improve location accuracy for 112 calls. This measure, developed by the Ministry of Research, Innovation and Digitalization (MCID), in collaboration with the Special Telecommunications Service (STS), and the National Authority for Management and Regulation in Communications (ANCOM), introduces new localization methods. The normative act follows the steps initiated by the Emergency Ordinance no. 48/2023¹⁸⁹ regarding some measures in the field of the 'single national system for emergency calls', which for the first time requires the implementation of several technical solutions at the level of European emergency services, in order to improve the localization of calls to the emergency number 112. Additionally, the ANCOM decision revises regulations to support multimedia emergency communications via IP-based services. After 2027, disabled end-users' access to emergency services will be available using voice, text, video, and other media in real time, improving communication during emergencies.

Expected changes in the context of the 2G and 3G switch-off: The technical changes take place in the context of the 3G and 2G networks switch-off, complementary to the development of 4G and 5G networks, which use IP technology to transmit data. These technical changes will facilitate the use of new technology to retrieve 112 calls and the corresponding location information, for calls initiated from new generation networks. Improvements in terms of the interconnection provided by the ANCOM decision, will be felt as soon as the new location solutions, established last year through primary legislation, for mobile calls initiated from 2G/3G/4G networks, are implemented at national level and also through the use of IP-based IMS technology. To obtain the most accurate location information, the user should have a smartphone type device with access to Internet services. Access of persons with disabilities to emergency services will also be ensured under conditions equivalent to those enjoyed by other users. Interconnection based on circuit-switching will be used as a backup solution for a time, until at least the full migration of emergency call transmission to the new technologies is completed.

New legal requirements: The decision revising the regulations on communications to the Single National System for Emergency Calls (SNUAU) also establishes a new obligation for mobile operators. Mobile operators must twice a year, transmit to ANCOM, a statistical situation appraisal of the terminals connected to the network, the first by 30 June, and the second by 31 December. The mobile operators should transmit each statistical situation appraisal specifying the names of the manufacturers, the names of the terminals, and the versions of the operating systems of the terminals (to the extent that the provider has access to the version information), as well as certain capabilities of the terminals. This statistical information will be used for analysing the dynamics of the types of terminals on the market that are capable of handling specific location methods, which are generally advanced mobile location (AML), or assisted global navigation satellite system (A-GNSS).

Challenges: The challenges associated with these upgraded technical requirements for emergency services stem from the very context of an important change, namely that of the phasing out of 3G and subsequently of 2G networks, while spurring the development of 4G and 5G networks. This change to new generation networks incurs among others, a complex series of social and economic adjustments, and users should be prepared to move on to new devices and services, and to associated new opportunities, including greater accuracy in emergency location information. Information campaigns tailored to reduce user reluctance concerning new technologies should be initiated, as well as education programmes aiming to help people overcome the digital literacy gap when migrating to the new terminals. Of course, as a prerequisite, the connectivity of new generation networks should be at least as widespread as that of the old networks, and handsets with the new functionalities should be available at an affordable price. From the experience of Romania, user reluctance can be mitigated

¹⁸⁸ New measures to improve the 112-caller location information, May 26, 2023, <https://sts.ro/en/noi-reglementari-pentru-imbunatatirea-localizarii-apelurilor-la-112/>.

¹⁸⁹ GOVERNMENT OF ROMANIA, EMERGENCY ORDINANCE no. 48 of May 26, 2023, regarding some measures in the field of the single national system for emergency calls, <https://sts.ro/fodidin/uploads/2023/10/81fc86cb4bfa8700.pdf>.

by comprehensive information campaigns. Such information campaigns should highlight the benefits of measures to improve the 112 service, given its primary objective of saving lives.

Conclusion: The decision to have mobile operators implementing new technical measures to improve location information for emergency calls to 112 is beneficial from several perspectives:

- It enables precise location information, crucial for quickly locating people in distress and saving lives.
- Leveraging IP technology and advanced smartphone features enhances localization and multimedia service use.
- Transitioning from 2G/3G to 4G/5G networks is essential for maintaining and improving emergency services.
- Ensures access for end-users with disabilities to emergency services under equivalent conditions to those enjoyed by the other end-users, promoting fairness in emergency services.
- The decision by ANCOM adapts services to new technologies and user needs, improving overall emergency response efficiency and public safety.

A1.3.13 New regulatory framework for the Alert Information System (Dominican Republic)¹⁹⁰

A new regulatory framework for the Alert Information System in Dominican Rep., aims at ensuring the dissemination of alerts, messages, and warnings in emergency or disaster situations, through public telecommunication service providers for the protection of human life and property, before, during, and after a crisis. The main body for coordinating operations and issuing emergency alerts in Dominican Rep. is the Emergency Operations Centre (COE). The texts of the alert messages are received at the COE, through specialized agencies, such as the National Meteorological Office or the Institute of Seismology, for dissemination and distribution to the entire population through social networks, and radio and television stations, etc. The system is activated by imminent natural or man-made disaster threats. Among the specific objectives of this standard are to guarantee the immediate dispatch and dissemination of messages in specific urban and rural areas, at no cost to the end user. Telecommunication providers should guarantee the necessary infrastructure for the transmission of alerts, including the use of technologies such as the cell broadcast service (CBS) for the mass sending of messages. The standard also states that in the event of officially declared disasters, guidelines for the transmission of alerts shall be written in plain and precise language. The type of information will be transmitted according to the event classification defined by the COE, in accordance with the protocols and procedures established in the National Emergency Plan and in the established Alert Declaration Process, or by a competent body duly authorized to issue an alert message.

A1.3.14 Management of risks and disasters (Republic of the Congo)¹⁹¹

The question of how to use telecommunications/ICTs for disaster risk reduction and management in developing countries is complex and multifaceted. The following are some of the key issues faced by developing countries in this area, as well as strategies for overcoming them:

¹⁹⁰ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0386/> from Dominican Republic.

¹⁹¹ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0162/> from Republic of the Congo.

Limited infrastructure: Developing countries often lack basic telecommunication infrastructure, such as reliable mobile telephone networks and Internet connections, which limits access to information and communications in the event of a disaster.

- Strategy: Invest in the development of basic telecommunication infrastructure, with emphasis on mobile technology and broadband networks, in order to improve connectivity in rural and isolated areas.

Limited resources: Developing countries often have limited financial, technical and human resources for implementing sophisticated technological solutions for disaster management.

- Strategy: Adopt simple, economical technological solutions, such as SMS messaging, "lite" mobile applications and radio communication systems, which are more accessible and easier to deploy in limited-resource environments.

Low levels of digital literacy: Many inhabitants of developing countries have a low level of digital literacy and limited experience with information technology, which can limit their capacity to make effective use of ICTs during disasters.

- Strategy: Introduce awareness-raising and training programmes on the use of ICTs, using teaching methods adapted to the literacy level and needs of local populations.

Cultural and linguistic barriers: Cultural and linguistic differences can hinder the effective dissemination of warning messages and information regarding disasters.

- Strategy: Adapt warning messages and information about disasters to local languages and cultural contexts, using widely used communication channels and region-specific social media channels.

Weak coordination between actors: Coordination between governments, aid organizations, civil society organizations, and the private sector can be weak, which can lead to a delayed disaster response and to the inefficient use of information technology.

- Strategy: Reinforce mechanisms of coordination and collaboration between the various actors involved in disaster management, by establishing public-private partnerships and encouraging the exchange of information and best practices.

Some practical examples are outlined in the table below:

Country	Law	Action
France	Law No. 2004-811 of 13 August 2004, on the modernization of civil security: The aim of this law is to modernize civil security, primarily by improving the use of ICTs for disaster prevention, preparedness and management.	Introduction of ICT-based surveillance and early warning systems; integration of digital technologies into disaster management plans; development of emergency communication platforms for authorities and citizens; and strengthening of coordination between actors involved in crisis management.
	https://www.pyrenees-atlantiques.gouv.fr/Actions-de-l-Etat/Securite/Protection-civile/La-planification/Le-systeme-de-planification-en-France	

(continued)

Country	Law	Action
United States	Post-Katrina Emergency Management Reform Act, 2006: The aim of this law is to improve the planning and coordination of relief efforts in the event of disaster, including through the use of ICTs.	Expansion of high-speed Internet access in high-risk zones; development of early warning and emergency communication systems; use of social media platforms to disseminate information and instructions in real time; and introduction of emergency operation coordination centres to facilitate disaster response.
	https://crsreports.congress.gov/product/pdf/IN/IN12277	
China	Law on disaster management of the People's Republic of China, 2007: This law provides for the use of ICTs for the prevention, prediction and management of natural and industrial disasters.	Strengthening of telecommunication infrastructure to improve resistance to natural disasters; development of surveillance and early alert systems; and improvement of coordination between government bodies, disaster relief agencies, and private businesses to facilitate an effective disaster response.
	http://www.npc.gov.cn/zgrdw/englishnpc/Law/2009-02/20/content_1471589.htm#:~:text=Article%201%20This%20Law%20is,the%20people%2C%20and%20maintaining%20national	
Australia	National Disaster Risk Reduction Framework, 2018: This law sets out provisions on the use of ICTs for disaster management, including the introduction of communication and early warning systems.	Development of emergency communication and early warning systems; integration of ICTs into disaster management plans; training of citizens on the use of digital safety tools; and introduction of follow-up and evaluation mechanisms to continually improve disaster preparedness and response efforts.
	https://www.lemonde.fr/idees/article/2020/01/03/incendies-en-australie-un-coup-de-semonce-politique_6024693_3232.html	
Republic of South Africa	Disaster Management Act, 2002: This law provides for the use of ICTs for disaster prevention, prediction, and management and for the rapid dissemination of information to affected populations.	Integration of ICTs in national emergency plans; development of emergency communication and early warning systems; provision of training on digital technology for responders to improve the coordination of relief activities; and public awareness-raising about digital tools for use in crisis management.
	https://www.gov.za/documents/disaster-management-act	

(continued)

Country	Law	Action
Ghana	National Disaster Management Organization Act, 1996: This law sets out provisions on the use of ICTs for disaster management and for the rapid dissemination of information to the competent authorities.	Awareness-raising and training on the use of ICTs for disaster management; development of emergency communication and early warning systems; strengthening of local capacities to ensure a swift and effective response to disasters; and introduction of mechanisms of coordination between government bodies and civil society organizations.
	https://www.preventionweb.net/publication/ghana-national-disaster-management-organisation-act-1996#:~:text=This%20act%20establishes%20a%20National,of%20persons%20affected%20by%20disasters	
Mauritius	National Disaster Risk Reduction and Management Act, 2006: This law provides for the use of ICTs for disaster prevention, prediction and management, including the introduction of early warning systems.	Strengthening of telecommunication infrastructure to ensure full coverage of national territory; development of emergency communication and early warning systems; integration of digital technologies into disaster management plans; and public awareness-raising about relevant tools.
	https://disasterlaw.ifrc.org/media/3021	

More references

https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/12/NETP_Report_R_Digital.pdf

<https://www.connectingbusiness.org/publications/gender-disaster-management-and-private-sector>

<https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/03/Mobile-for-Development-Utilities-Digital-Solutions-for-the-Urban-Poor.pdf>

A1.3.15 Implementing national emergency telecommunications planning and building greater national and regional preparedness (UN WFP-ETC, GSMA))¹⁹²

In times of crisis, connectivity is a lifeline. In a crisis situation the ability to call for help, find information online, or contact friends and family can be the difference between life and death. However, natural hazards, disasters, and conflicts often damage telecommunications infrastructure, leaving responders and affected populations stranded. National emergency telecommunications preparedness is a critical priority that, spurred by capacity development, has been gaining primacy in recent years. Coordinated by ITU, the Emergency Telecommunications Cluster (ETC), and GSMA have been putting in place National Emergency Telecommunications Plans (NETP) for countries across the world. The need for national emergency telecommunications preparedness was underlined by the United Nations Secretary-General's call for inclusive EWSs under the 'Early Warnings for All' initiative¹⁹³. Both national governments and intergovernmental bodies have been ramping up their implementation efforts not just in emergency telecommunication protocols, procedures and policies, but also in enhancing national capacities, and by sharing lessons and knowledge across borders. The ETC and the GSMA are

¹⁹² ITU-D Document <https://www.itu.int/md/D22-SG01-C-0472/> from UN World Food Programme (WFP)-led, Emergency Telecommunications Cluster (ETC), GSM Association (GSMA).

¹⁹³ <https://www.un.org/en/climatechange/early-warnings-for-all>.

playing a crucial role in complementing these efforts, by enabling national and regional implementation and ownership. The principal areas where these efforts have been made are outlined, with some key areas identified below:

- **National coordination mechanisms:** One of the most important aspects of preparedness is coordination. Identifying which agencies are responsible for what, ahead of time is critical, as is identifying how various agencies collaborate, so that when an emergency arises, roles and responsibilities are clearly laid out, and the competencies and expertise of each actor is maximized. In the spirit of enhancing coordination, the GSMA brings together government agencies and private sector partners at 'Humanitarian Connectivity Charter' workshops to enable a more coordinated and predictable response to disasters. In 2024, regional workshops in Kenya (targeting the wider African region), Barbados (targeting the Caribbean region) and the Republic of the Philippines (targeting the Asia-Pacific region) brought together representatives from telecommunications regulators, national disaster management authorities, humanitarian organizations, and the private sector. Sessions focused on EWSs, anticipatory action, and creating specific action plans with key stakeholders. Other discussions identified gaps in communications preparedness and coordination and needs within the region. These sessions helped stakeholders clarify roles and coordinate response strategies, ensuring preparedness for emergencies.
- **Strengthening NETP Implementation:** Since 2021, the WFP-led ETC has been providing technical support and advice in establishing and strengthening national emergency ICT coordination mechanisms in high-disaster-risk countries. This includes support to national disaster management authorities and regulatory bodies in Dominican Rep., Mozambique, Rwanda, Republic of Madagascar, Zimbabwe, Mongolia, Ghana, and Malawi. In six of these countries, NETPs had either been ratified or were in development. These national coordination structures play a key role in implementing the priority areas and action points outlined in the NETPs, offering an inclusive and cohesive platform for stakeholders to collaborate on capacity development, preparedness, response efforts, and infrastructure improvement.
- **Building regional NETPs:** Additionally, the ETC has provided sub-regional coordination assistance in three crucial regions: 1) the Pacific region, also engaging the Secretariat of the Pacific Community (SPC); 2) the Caribbean region, working closely with the Caribbean Disaster Emergency Management Agency (CDEMA); and 3) Southern Africa region, collaborating closely with the Southern African Development Community (SADC). The ETC and the GSMA actively collaborated with SADC, under ITU-led processes, in reviewing and developing the 'Regional Model NETP' in May 2023, resulting in a model NETP created by SADC and experts, for customization by Southern African Member States.

Case studies in strengthening national disaster ICT response capacity. The ETC and the GSMA, in collaboration with key partners such as ITU and relevant WFP country offices and Regional Bureaus, have actively strengthened national capacities to respond to disasters. Some country cases are detailed as follows:

- **Rwanda:** After national validation in March 2024, the ETC contributed to validation of the NETP for Rwanda, under ITU coordinated processes. At the request of the Government, the ETC and WFP Rwanda conducted national emergency preparedness workshops

in August 2024 and January 2025, strengthening the skills and coordination of three ministries, five agencies, and three United Nations and civil society entities. This led to the creation of a national ICT emergency coordination body, tasked with implementing the NETP. As part of the workshop in 2024, the ETC designed a 'flood and landslide desktop simulation' for 32 participants, testing national disaster management policies and emergency telecommunications protocols. The lessons are now guiding the work of the telecommunications coordination body, starting with the development of a standard operating procedure (SOP) for emergency preparedness. A follow-up workshop in 2025, saw the development of a draft standard operating procedure for guiding the work of a future telecommunications cluster.

- **Malawi:** Following the development of an NETP in May 2023, the ETC responded to a national request to assess capacities, and identify collaboration opportunities among stakeholders, in the emergency telecommunications sector. This was completed in June 2023, leading to the formation of a national ICT working group with representatives from the Government, private sector, and United Nations system. A key priority was practical training, and in January 2024, the ETC organized a cyclone-based desktop simulation for 41 national participants in Malawi, using the NETP as a reference. The simulation highlighted coordination and capacity gaps, guiding the future efforts of the groups, including developing a standard operating procedure (SOP) for emergency telecommunications coordination, inspired by practices from the 'Global South'. Between 2024 and 2025, the working group also prepared an SOP for emergency telecommunications preparedness.
- **Dominican Rep.:** The ETC and WFP Country Office have worked closely with the Government of Dominican Rep., to strengthen disaster risk management and emergency telecommunications capacities. In 2021, they co-hosted a national capacity-building workshop that laid the groundwork for forming a national ETC coordination mechanism. This followed the 2018 NETP, which stressed the need for improved national coordination and capacity development in telecommunications for emergency preparedness. During the response to Hurricane Fiona in September 2022, WFP contributed to drone-based damage assessments and provided telecommunications equipment, enabling local technicians to restore communications. As part of the response, the ITU-ETC-GSMA Disaster Connectivity Map was activated, which helped identify connectivity blackspots, guiding the prioritization of communication restoration efforts in 'high-damage areas'.
- **Islamic Republic of Pakistan:** The GSMA hosted a Humanitarian Connectivity Charter (HCC) National Convening on 11-12 December 2024, which included a disaster simulation desktop exercise, jointly run with UNICEF. The primary objective of the Convening in Pakistan, was to bring together stakeholders from across the mobile ecosystem, government, and the humanitarian sector to discuss and strategize on improving mobile-enabled disaster resilience in the country. Crucially, this included the development and implementation of a mobile-enabled EWS.

Facilitating regional support and collaboration

Southern African Development Community (SADC) region: Building regional connections and facilitating 'lessons learned' exchanges, the ETC convened national project focal points, and government representatives from three SADC countries, Mozambique, Madagascar, and Malawi from

21-23 June 2023, in Maputo. Realizing the severe vulnerability of all the countries in the SADC region, the ETC subsequently worked with SADC through the WFP Liaison Office in Republic of Botswana, to develop a proof-of-concept and workplan outlining high-impact cooperation activities, including activities on capacity development, knowledge exchange, and equipment advisory. A major milestone was the participation of ETC as a faculty advisor under the UNDAC-convened 'Emergency Response Training' in Botswana in July 2024, where 30 participants from 15 Member States were trained in emergency preparedness and response essentials, including a module on telecommunications, and a field simulation which tested communications vulnerabilities in a cyclone scenario.

Caribbean region: Recalling the extensive preparedness and response support provided for the Caribbean region, including response operations in Haiti, Dominican Rep., and the Commonwealth of the Bahamas, the ETC joined hands with ITU and the GSMA to run an emergency preparedness workshop for 49 participants from regional bodies and governments from Caribbean states at the end of 2023. The main outcomes were knowledge exchange and peer-to-peer learning across islands, culminating in a desk-top simulation testing readiness and response efficiency in a hurricane context. A follow-up workshop in October 2024, included an 'after-action review' of the Hurricane Beryl response, and agreement to form a regional community of practice in emergency telecommunications preparedness across the island states.

Facilitating Government-to-Government collaboration: In Ghana, following establishment of the national ICT working group with a technical advisory provided by the ETC and WFP Ghana in May 2023, priority was accorded to peer-to-peer learning and EWS development. Officials of the Government of Ghana went to India in 2023 on a study visit to learn more about national practices in ICT and disaster risk management. These findings have inspired national preparedness efforts in ICT readiness in the country.

Lessons learned: A final area of preparedness where the GSMA and the ETC have supported national and regional governments is compiling the lessons learned across numerous interventions and sharing these. This has primarily been achieved through both technical support, as well as documentation of lessons learned. The GSMA, for example, has published several reports highlighting best practices and lessons learned around the topics of inclusivity in EWSs in South Africa¹⁹⁴, the use of CB in EWS¹⁹⁵, and the role of the mobile industry in supporting resilience. These reports have been used to share lessons learned with national disaster management agencies¹⁹⁶ and telecommunications regulators. Some of the lessons learned are outlined below:

- **Enhancing national and regional coordination:** Identifying relevant national/regional agencies, and focal points, and ensuring roles and responsibilities are clearly articulated and understood is key. Policy mechanisms such as NETPs and emergency telecommunications standard operating procedures (SOPs) can play a key role in clarifying processes, roles, and responsibilities. Workshops or events can help connect relevant stakeholders.
- **Investing further in capacity development:** Trainings, capacity mapping, and simulation exercises can help to ensure that relevant government stakeholders have the requisite skills and knowledge ahead of an emergency, while enhancing investments in these engagements is crucial for developing national responders. Testing systems, protocols, and capacities also enhances national preparedness.

¹⁹⁴ https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/gsma_resources/enhancing-inclusion-in-mobile-enabled-risk-communications-lessons-from-south-africa/

¹⁹⁵ https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/gsma_resources/cell-broadcast-for-early-warning-systems-a-review-of-the-technology-and-how-to-implement-it/

¹⁹⁶ https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/gsma_resources/building-a-resilient-industry-how-mobile-network-operators-prepare-for-and-respond-to-natural-disasters/

- **Sustaining capacity development:** There should be capacity assessment interventions undertaken to assess readiness for disasters at intervals, and proliferating training-of-trainer learning approaches to retain institutional knowledge in case of staff movements.
- **South-South lessons learned exercises to share knowledge:** Globally, government stakeholders can also learn from one another through the documentation and dissemination of lessons learned, knowledge exchange and peer-to-peer learning. Communities of practice can pool critical knowledge, resources, and expertise to deliver a more coordinated response in the future, including leveraging regional capacities (equipment and responders).
- **Mainstreaming emergency preparedness in national planning:** Backing emergency preparedness interventions with adequate financial provisions in national plans, is crucial to ensure the sustainability of the interventions over time. It also provides an opportunity for national planning cycles to sustainably tackle long-range development interventions which could include commitments such as enhancing early warning infrastructure, amongst others.

Conclusion: NETPs and other national protocols and policies are foundational for guiding emergency telecommunications preparedness and response efforts. These efforts highlight how countries are operationalizing their NETPs and enhancing resilience nationally and regionally. However, following the development of an NETP, there are many measures national governments can take to implement national and regional emergency telecommunications planning, and to improve emergency telecommunications preparedness and resilience to natural hazards. As climate change continues to increase the frequency and severity of disasters, effective preparedness and resilience is, and will, continue to be critical. Preparedness is key.

A1.4 Disaster communication technologies

A1.4.1 Rescue procedures applied at Vila do Sahy in São Sebastião, São Paulo, Brazil¹⁹⁷

The use of radiogoniometry in order to save lives in disasters: The 683 millimetres of rain that fell in Vila do Sahy region between 18 and 19 February 2023, were the highest recorded rainfall during a 24 hour span in the history of Brazil, according to data from the National Centre for Monitoring and Alerts of Natural Disasters (Cemaden, <http://www2.cemaden.gov.br>) and the National Institute of Meteorology (Inmet, <https://portal.inmet.gov.br>). The following day, 20 February 2023, Anatel, the Brazilian Telecommunication Regulatory Agency, provided technicians and equipment to help Civil Defence and the Fire Department rescue personnel. Anatel technicians operated spectrum analysers, tuned on through cellular mobile networks reverse links, with coupled directive antennas to locate people buried in the mud and rubble.

Procedures applied to rescuing people: The technique applied by Anatel in Vila do Sahy, was to use a directive antenna connected to a spectrum analyser, in order to manually search for the direction of the maximum level of received signal, as shown in Figure A-30 and Figure A-31.

¹⁹⁷ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0144/> from Brazil.

Figure A-30: Spectrum analyser with directive antenna



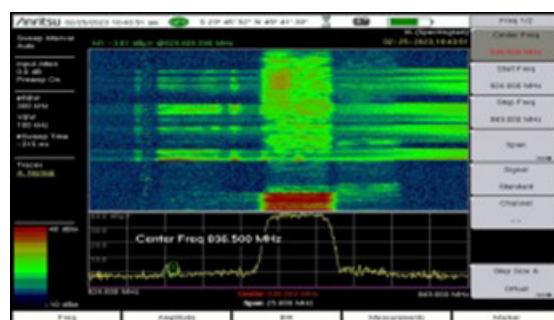
The spectrum analyser was tuned in the following frequencies bands, used in the cellular mobile network uplinks: 703-748 MHz; 824-849 MHz; 890-910 MHz; 1 710-1 785 MHz; 1 895-1 900 MHz; 1 920-1 975 MHz; and 2 500-2 570 MHz.

Figure A-31: Spectrum analyser operation



Radio frequency analysis: For this rescue operation procedure Anatel technicians first set-up and stored uplink frequencies on a spectrum analyser, in order to reduce the scanning time for signals. Everybody present in the rescue area then turned off their mobile phones. Analysis of the signals transmitted by the reverse links of the mobile phones of buried victims helped in mapping of areas where signals indicated the possible presence of victims. Figure A-32 shows the presence of signals in the 824-849 MHz band.

Figure A-32: Analysis of uplink frequencies



Georeferencing areas: After locating radio frequency (RF) signals transmitted by the reverse links of victims' mobile phones, the area was georeferenced (latitude and longitude) to optimize the excavations to find people. Civil Defence personnel then used sniffer dogs to locate both living and deceased people. The use of sniffer dogs helped in confirming the areas demarcated by the Anatel technicians.

Excavation: Locating signals transmitted by the mobile phones of buried people, and confirming the presence of bodies reduced the area of excavations to be carried out by Civil Defence personnel. Figure A-33 shows the locating and digging operations in the rescue areas.

Figure A-33: Locating and digging operations in the rescue areas



Conclusion: The use of a spectrum analyser by Anatel technicians was important in defining rescue excavation areas and finding people. The Civil Defence reported that the estimated time required for the planned excavation activities in the areas affected by the natural disaster at Vila do Sahy was reduced to a third of the originally planned intervention. The Civil Defence also reported that the procedure carried out by Anatel technicians will form a part of future rescue operations. Anatel formed a Study Group to develop a Technical Specification and action plan to detail the activities and procedures applied in São Sebastião for future rescue operations.

A1.4.2 A high-altitude base station for vertical take-off and landing (VTOL) fixed-wing UAVs for emergency communications (China Mobile)¹⁹⁸

Due to the impact of climate change, the frequency and intensity of natural disasters has been gradually increasing around the world. There is now an increased probability of weather induced events such as floods, droughts, low temperatures, extreme rainfall, freezing temperatures, and forest and grassland fires. The disaster risk situation is severe and complex, as disasters are increasingly being experienced with a widening distribution, rising frequency, and often heavy losses. Disaster recovery communication has gradually become a key step in rescue operations, and emergency communication is an important support for post-disaster relief. In areas with poor transport and power supply infrastructure, the ability to cope with disasters such as flash floods, or earthquakes is reduced. Communications can also be interrupted due to damage to fibre-optic cables and base stations, but real-time transmission of post-disaster information is crucial for successful emergency rescue operations. Today 70 per cent of the world, comprised mainly the high seas regions, deserts, forests, plateaus, and other remote areas, remain without adequate ground communication network coverage. In such areas, and the same applies to low-income areas, the construction of base stations can be a difficult and costly undertaking. The result is that many areas remain virtual islands cut-off from communication, and in such areas when a disaster occurs, the post-disaster situation cannot be quickly transmitted back to a rescue operations team. In summary, in the case of power failures, limited or severely damaged networks, or network disconnections, a system that can quickly arrive at the disaster scene to provide emergency communication within the "golden rescue period" timeframe is needed. A high-altitude base station system based on a medium-size vertical take-off and landing (VTOL) fixed-wing unmanned aerial vehicle (UAV) platform can realize aircraft control and link returns through satellite communication, and can use the airborne base station to quickly restore local communication in the case of disconnection, or power or transmission failure in the disaster area, and can even carry a micro-pod to send real-time video and infrared detection data. Such systems also have the advantages of wide coverage, flexible deployment, and low line-of-sight propagation attenuation. The above advantages can be deployed in remote areas and post-disaster areas to ensure smooth communication.

¹⁹⁸ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0217/> from China Mobile Communications Corporation.

Composition and characteristics of a medium VTOL fixed wing UAV: Common solutions employed for high-altitude base station lift-off are large UAVs or unmanned airships. Negative aspects of these solutions include their high cost, difficulties concerning aircraft control and deployment, the requirement for a suitable airport, low security issues, and consequently difficulties in meeting the urgent and real-time communication requirements of emergency situations. UAV high-altitude base stations are more suitable for post-disaster deployment. The UAVs commonly used for emergency communication include tethered UAVs, large fixed-wing UAVs, and medium-sized fixed-wing vertical take-off and landing (VTOL) UAVs.

Figure A-34: Image of UAV



In towed UAV systems, a UAV tows a secondary aerial platform that is connected to the ground and provides continuous power supply through photoelectric composite cables. However, if roads are disrupted or non-existent, such systems may only reach the edge rather than the centre of the disaster area to restore communication. Large fixed-wing UAVs require large airports, are expensive, require high-end professional operators, and are difficult to use. Medium VTOL fixed-wing UAVs do not need a special airport, are simpler to operate, and are more suitable for emergency communication scenarios.

Technical principle of high-altitude base station of medium VTOL fixed wing UAV. Medium-size VTOL fixed wing UAVs adopt a technology combination of "VTOL fixed wing UAV + airborne satellite communication system + base station + micro-pod + data fusion module". Medium VTOL fixed wing UAVs use a hybrid mode of fuel and electric power, allowing such systems to remain at altitude for extended periods. Requirements for take-off and landing sites are minimal, and they do not require the extensive runway required by large fixed-wing UAVs. The airborne satellite communication system is used to realize the 'data return and control link' mechanisms for controlling and managing the flow of data, and they have sufficient space aboard for the installation of a base station. The 48V power supply required by the base station to realize the communications application of air base stations, is provided by the aircraft power supply system. A micro-pod can be installed to send images of the mission back to the flight control centre and the user interface in real time, providing a basis for decision-making and support. These aircraft also comprise an emergency safety protection mechanism which causes the aircraft return to base in the event of data link signal loss, an abnormal drop in altitude, low voltage, or GPS signal loss.

Figure A-35: Image of telecommunication networks using UAVs



Improved coverage breadth: Traditional emergency communication operations after a disaster usually employ emergency vehicles to deploy emergency base stations, but the height of these emergency base stations is generally limited to a height of approximately 15 metres, and consequently coverage is limited. High-altitude base stations use the advantages of high-altitude to build line-of-sight propagation links, which can effectively overcome the propagation loss of electromagnetic waves. With the launch of a UAV base station platform, the coverage radius of high-altitude base stations expands rapidly. High-altitude base stations employing UAVs as lift-off platforms are therefore more suited for deployment in post-disaster areas. The independent broadband satellite communication UAV system greatly improves the signal breadth and depth and solves the problem of over-the-horizon communication. A network equipped with an FDD900 standard base station can cover about 30 square kilometres, and the coverage area can be adjusted at any time.

Beyond line-of-sight long range flight control: Common systems used for UAV control and data return link include ground stations, Wi-Fi, mobile communication network, and satellite communication. The wireless communication environment in disaster areas is usually complex and rarely meets the conditions required for line-of-sight propagation. In order to overcome signal instability factors such as the Earth curvature, and mountain terrain occlusion, and to ensure ultra-long distance control, high-throughput satellite communication is used as the main return link. UAV control can be achieved anywhere within the coverage of the satellite, with a wide range of long-range, low-altitude, controllable and visual flight capabilities. Safety control features include low-orbit narrowband satellites, digital radio, and remote control three-fold control insurance.

Improving coverage mobility: While roads in post-disaster areas are often disrupted and communication is difficult, UAVs can enter the disaster area before roads have been restored by using the air route. Medium fixed wing UAVs with vertical take-off and landing do not need airports and runways, and can be transported to the take-off site in a single van or truck. When fully fuelled, UAVs can maintain flight for up to eight hours while flying as close to the ground as possible, while hover height can be as low as 100 metres. This system then combines the characteristics of flexibility and long endurance. Medium fixed wing UAVs with VTOL can be used to provide temporary emergency communication coverage, and network support for emergency command and disaster transmission, in areas that are otherwise cut-off from communications.

Connecting the command centre to the site: The command centre and the disaster site are often in a state of information asymmetry and asynchronicity, making it difficult to formulate an overall strategic and timely plan. Being able to realize intelligent monitoring and management of flight tasks, responds to demands for real-time supervision and command, and promotes industry applications. After using high-throughput satellites to transmit information in real time, an AI platform can be used to carry out image recognition on the UAV return video, automatically identifying people and hazards.

Infrared sensors and wind speed measuring instruments can be added to the UAV to accurately locate fire sources and direction of fire propagation.

Application case: In 2023, a typhoon and heavy rain in Hebei and Heilongjiang caused widespread damage, and vertical take-off and landing fixed-wing UAVs were used to quickly restore communication and real-time video back to a control centre from the disaster area. In Heilongjiang, a medium-sized VTOL fixed-wing high-altitude base station UAV was used to perform three flight missions (including a night flight, and a flight in force 6 wind speeds), with an average flight time of 1.5 hours, a distance covered of 135 kilometres, and all of this at the maximum flight control distance of 15 kilometres from the take-off point. A total of 427 emergency personnel in the disaster zone were connected, helping the last four villages in the province to restore communication. In Hebei Province, a medium-size VTOL fixed-wing high-altitude base station was used to carry out three flight missions, with an average flight time of two hours. The actual maximum flight control distance was 20 kilometres from the take-off point and a flight altitude of 800 metres was maintained. A total of 1 428 connected emergency personnel helped resolve the regional communication isolation problem.

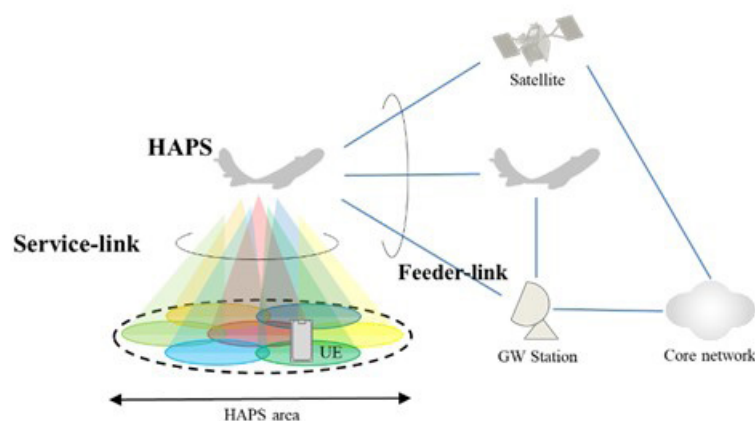
Recommendation. This paper introduces a high-altitude base station used for emergency communication. Its flexible and mobile features such as wide coverage capability, etc., can help ensure the rapid recovery of communications in disaster areas. The system can be widely used in emergency communication and promises multiple solutions and application areas. The high-altitude base station is an important part of the space-based network of the future 6G air-earth integrated communication network. The high-altitude base station with a medium UAV as the lift-off platform combines the characteristics of fast mobility, flexibility, and wide coverage. Capable of realizing beyond line-of-sight flight control and data retrieval through high-throughput satellite communication systems, it can also be used as an innovative solution for large-scale network interruptions of mobile communication caused by sudden disasters or events.

A1.4.3 High altitude platform station (HAPS) systems (Softbank)¹⁹⁹

Overview of the HAPS system: High altitude platform station (HAPS) systems are located on uncrewed aircraft at an altitude of approximately 20 km, in stationary rotation in the stratosphere. Operating in the stratosphere, where atmospheric conditions throughout the year are stable with little change in wind speeds, allows HAPS to fly with stability. Comprising a large wingspan, HAPS can carry high-performance payloads and solar panels, and can cover a communication area of up to 200 km in diameter while relying on a self-sufficient power source for extended flight periods. HAPS offers a suitable solution for areas where ground networks are not available, such as in the air, on remote islands or mountainous areas, and in developing countries or regions that are difficult to cover with ground base stations. In the event of a disaster, HAPS can also be rushed to the disaster area immediately to recover the communication. As shown in Figure A-36, two types of communication service, "service link" and "feeder link" are required for HAPS operation. The feeder link is a one-to-one communication between the HAPS and a gateway station, while the service link provides one-to-many communication directly to regular user equipment.

¹⁹⁹ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0205/> from Softbank, Japan.

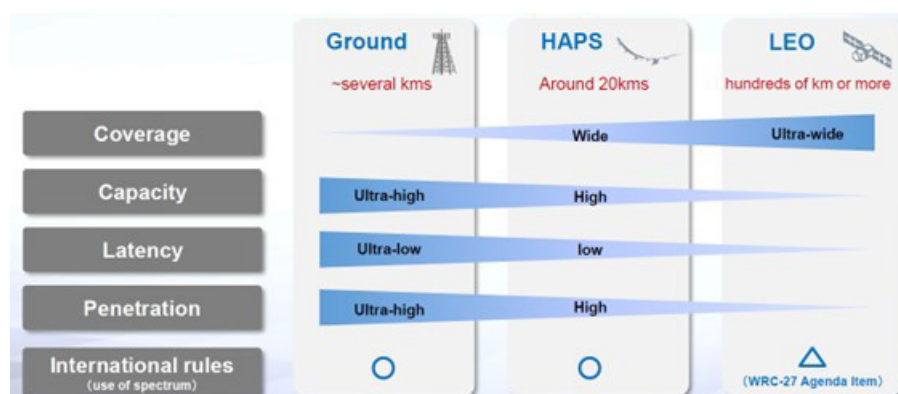
Figure A-36: Different types of links for HAPS communication



Under previous ITU-R Radio Regulations (RR), it was possible to operate HAPS service link using the 2 GHz mobile spectrum band, but the usage of other global mobile spectrum bands was prohibited. At the World Radiocommunication Conference 2023 (WRC-23), held in Dubai, United Arab Emirates, from 20 November to 15 December 2023, the expansion of HAPS spectrum to add three additional mobile spectrum bands, namely 700-900 MHz, 1.7 GHz, and 2.5 GHz, was formally agreed upon. It is to be expected that the revision of RR, approved during the conference, will be implemented in the national regulations of each country, in order to utilize these new frequency bands for use of HAPS service link. As the result, when introducing HAPS-based mobile broadband communication services, the spectrum can be chosen with greater flexibility in different countries and regions, thereby enabling seamless usage with existing smartphones and other devices.

Figure A-37 shows a comparison of NTN direct to device (D2D) communication services in the stratosphere and the space.

Figure A-37: Comparison of NTN D2D communications



As they orbit at distances of hundreds of kilometres or more from the earth's surface, low Earth orbit (LEO) satellites can provide wide coverage. However, HAPS, among other NTN solutions, has the advantages of higher capacity, lower latency, and better penetration, similar to terrestrial networks. HAPS therefore, would not only provide basic communication services such as messaging and voice services, but would also provide richer services such as mobile Internet and entertainment services across wide areas.

Emergency communications and disaster recovery. Following a disaster, affected communities frequently encounter communication breakdowns, impeding their capacity to seek aid, connect with family, or obtain crucial information. Restoring communication entails implementing communication infrastructure and technologies to facilitate dependable and prompt information exchange among

emergency responders, affected communities, and pertinent authorities. The aim is to facilitate rapid and effective communication, bolster situational awareness, assist in search and rescue operations, and facilitate the recovery and reconstruction efforts in the aftermath of a disaster. On 11 March, 2011, Japan experienced a catastrophic event when a magnitude 9.0 earthquake struck off the Sanriku coast, triggering strong tremors and generating massive tsunami waves along the Pacific coastline. This disaster, famously known as the Great East Japan Earthquake, inflicted severe damage from the Tohoku to Kanto regions. The earthquake and ensuing tsunami wreaked havoc on telecommunication infrastructure, leading to the collapse or washing away of numerous cell phone base stations. Within a day, communication services were suspended due to widespread power outages, causing battery depletion. Approximately 29 000 cell phone base stations went offline initially. While restoration efforts and the return of electricity helped reduce outages, aftershocks prolonged the restoration process, and almost two months passed before telecommunication companies could fully restore services²⁰⁰.

On New Year's Day 2024, a 7.6 magnitude earthquake struck the remote Noto peninsula. After two weeks of emergency mobile network restoration operations, using portable equipment and wired power feed drones etc., communication services were still unavailable in areas made inaccessible due to road infrastructure damage. The Nankai Trough recurring megathrust earthquake (M8 class) poses a significant threat to the future for Japan, with a predicted probability of occurrence at some point over the next 30 years of 70 to 80 per cent. This escalating probability adds a heightened urgency to preparation measures as time progresses²⁰¹. In the event of a major disaster in the Tokai region, where up to 40 per cent of ground base stations may be incapacitated in affected areas, it could take several days to restore communications²⁰². The "golden 72 hours" principle underscores the need for a quality of service (QoS) capable of facilitating video call services for precise medical interventions and communication with people trapped in enclosed spaces, or under the rubble of collapsed buildings. In such cases, and when considering the emergency and specific penetration needs, only HAPS could provide timely solution for the restoration of communication.

Industry developments and achievements in HAPS: HAPS industries have achieved a number of remarkable developments HAPS technologies. HAPS Alliance, is well known as the consortium targeting the construction a cooperative HAPS ecosystem, and has released several publications, including whitepapers, introducing the latest achievements²⁰³ and stratosphere flight test results²⁰⁴.

A1.4.4 Shipboard base station (KDDI)²⁰⁵

On 6 January 2024, in response to the Noto Peninsula earthquake, two major mobile telecommunication carriers in Japan, NTT Docomo and KDDI, jointly began operating a "shipboard base station", which is a mobile phone base station installed on a ship. NTT Docomo and KDDI mobile phone base station equipment was installed on the "Kizuna", a submarine cable-laying ship operated by NTT World Engineering Marine, of the NTT Docomo Group. By transmitting radio waves received by satellite antennas to end users from the ship, they aimed to restore communications to some coastal areas of Wajima City, Ishikawa Prefecture, where recovery operations were proving difficult because

²⁰⁰ White paper Information and Communications in Japan Year 2011 (<https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/h23/pdf/n0010000.pdf>, in Japanese).

²⁰¹ Long-term evaluation on Active faults and trench earthquakes published on January 15, 2024 (<https://www.jishin.go.jp/main/choukihyoka/ichiran.pdf>, in Japanese).

²⁰² Damage Assumption for a Nankai Trough Earthquake (Damage to Facilities, etc.) (https://www.bousai.go.jp/jishin/nankai/taisaku_wg/pdf/1_sanko.pdf, in Japanese).

²⁰³ HAPS Alliance Member Achievements (https://hapsalliance.org/wp-content/uploads/formidable/16/HAPSAlliance_MemberAchievements_Q3_2023.pdf).

²⁰⁴ White paper Bridging the Digital Divide with Aviation in the Stratosphere (https://hapsalliance.org/wp-content/uploads/formidable/12/SpA_Flight_Communication_Tests_White_Paper_English_Final_2021.pdf).

²⁰⁵ ITU-D Document <https://www.itu.int/md/D22-SG02.RGQ-C-0148/> from KDDI, Japan.

land routes had been cut off by the earthquake. This operation was part of the social contribution collaboration agreement that NTT and KDDI signed in 2020, and that also includes other mutual cooperation operations, such as the transportation of supplies during disasters.

Figure A-38: Shipboard base station



A1.4.5 Direct-to-handset (D2H) technology in disaster communications (Access Partnership)²⁰⁶

Introduction to D2H technology: Not so long ago, terminal devices required large power supply modules and sizable, deployable antennas to communicate with satellites, a service known as 'mobile satellite service' (MSS). However, recent technological advancements in design and manufacturing have substantially reduced the size, weight, power, and cost of electronic communication equipment. Consequently, smaller phone forms can now accommodate the necessary power supply and antenna, leading to several industry players announcing their intentions to enter the emerging direct-to-handset (D2H) market. Emergency services, and disaster risk reduction and management provide a clear viable example of the D2H use case. Expanded coverage to areas not reached by traditional terrestrial networks, or if terrestrial networks are offline due to a national disaster, provides governments and emergency service operators with a viable communication technology that can help to save lives and mitigate further disaster. While the advent of D2H services represents an exciting and unprecedented technological milestone, the lack of coherent global regulations combined with other challenges, such as spectrum coordination, interference, and resource allocation, require broad encompassing solutions.

Disaster frequency on the rise: The frequency of disasters is rising at an alarming rate, even surpassing the most pessimistic forecasts, and especially so given the onslaught of climate change. While various weather-related disasters will impact countries of all development stages, low-income nations are especially vulnerable to the effects of climate change. Due to limited technical and human resources, and inadequate investment in infrastructure and equipment, such countries are often ill-equipped to handle the fallout and associated costs of disaster. The economic impact of natural disasters is also expected to increase significantly. Consistent with the trend of the rising frequency of natural disasters, the average economic impact of natural disasters has increased by more than three times from an annual average of USD 56 billion per annum between 1980 to 1984, to an annual average of USD 199 billion between 2015 to 2019.

Impact of D2H on disaster risk management: The emergence of D2H services as a viable means to expand coverage has the potential to transform both government and service provider approaches to disaster risk reduction and management. This is because the benefits of D2H satellite services are not limited to reaching areas that are otherwise difficult or impossible to reach through traditional networks, but they are also crucial in providing backup connectivity in the wake of a natural disaster, where terrestrial communication infrastructure is temporarily damaged and unavailable. The initial phase of the service, as is the case currently, has been dominated by the provision of limited D2H

²⁰⁶ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0240/> from Access Partnership Limited.

services, with a focus mainly on emergency messaging. Already, 'handhelds' such as the 'Reach' (Garmin) and 'Spot X' (GlobalStar) have implemented satellite connectivity, with early adoption among users of satellite phones and satellite-powered gadgets, such as hikers and mountaineers who are not otherwise able to access cellular connectivity through their mobile devices. However, D2H, through its utilization of satellite technology, has the greatest potential impact in remote communities, which traditionally face disproportionate challenges in receiving updates related to natural disasters.²⁰⁷ With D2H services offering these underserved locations a cheaper alternative access to mobile broadband, such 'handheld' tools can be used to facilitate faster and timelier responses to natural disasters.

Reliable communication systems during times of disasters are critical in ensuring effective access to response and relief activities. For example, during the 2020 Cyclone Harold in the Solomon Islands, Vanuatu, Republic of Fiji, and Tonga, the communications equipment provided by ITU and [Kacific](#) meant locals affected by the disaster were able to access the community Wi-Fi service and quickly deploy disaster relief assistance, even after local network coverage was wiped out. This technology has become increasingly pertinent with the frequency of natural disasters expected to rise due to climate change.²⁰⁸ Analysis by Access Partnership, estimates that under a 'business-as-usual' scenario, the global cost of natural disasters could reach approximately USD 320 million per year from 2023 onwards, constituting infrastructure damage, loss of life, and increased morbidity. However, improvements to communication systems facilitated by D2H services could reduce the impact of natural disasters by up to 38 per cent, meaning approximately USD 120 million worth of economic impact could be mitigated per year from 2023.

Direct-to-handset satellite services: When terrestrial networks are damaged or destroyed by disaster, one of the greatest challenges for responders is often the transportation and setting up of telecommunication equipment such as satellite terminals in the disaster site. In some cases, this may also involve bureaucratic and administrative processes in addition to purely logistical hardships. The 'Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations' specifically touched upon this problem with a dedicated article titled 'Regulatory Barriers'. With D2H technology, both logistical and administrative problems and delays can be overcome very quickly by using resilient satellite networks with smartphones.

Direct-to-handset satellite services can also enable remote medical consultations and telemedicine services, which can be especially beneficial for patients in remote or underserved areas.

Additional benefits of promoting widespread connectivity: As of 2023, nearly a quarter of the world's population still lack access to modern communications.²⁰⁹ While the value of investments required to set up D2H infrastructure will be significant, the potential economic impact that D2H technologies offer to broader society mean such investments could be necessary. With around a quarter of the population across the globe living outside the reach of modern communication systems, there is a significant proportion of economic potential yet to be captured due to this lost connectivity. A study by ITU in 2018, covering 139 economies across the globe revealed that every percentage point increase in mobile broadband penetration increases GDP by 0.15 per cent.²¹⁰ Connecting the more than two billion individuals who do not regularly use the Internet today, could add an estimated USD 1.2 trillion to global GDP through various cost savings and productivity improvements.

Road ahead: The coming years of transition to a new era in D2H satellite communications, promise a number of transformative developments in the sector. There have been calls for greater

²⁰⁷ <https://www.sciencedirect.com/science/article/pii/S2212420920314333>

²⁰⁸ Intergovernmental Panel on Climate Change (2021), "Climate change widespread, rapid, and intensifying – IPCC." Available at: <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>.

²⁰⁹ [With Almost Half of World's Population Still Offline, Digital Divide Risks Becoming 'New Face of Inequality'](#), Deputy Secretary-General Warns General Assembly | UN Press.

²¹⁰ https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/FINAL_1d_18-00513_Broadband-and-Digital-Transformation-E.pdf

multistakeholder action to ensure a robust, effective, and harmonized communication plan and strategy to face the increasing number of natural disasters that are likely to impact countries. Policy and regulation play a critical role in ensuring timely and effective disaster responses by enabling the rapid deployment of essential emergency communication technology. Additionally, disaster response speed can be further increased by facilitating emergency response capabilities, developing expedited licensing for emergency communications, and enabling good-faith partnerships with international private network operators. There is a need for regulating future technologies, prioritizing user-centred and widely accessible solutions, and for partnering with the private sector to deliver activation protocols and promote national and international coordination. Finally, the role of low Earth orbit (LEO) constellations, and moderating competition concerns in order to enable network complementarity and redundancy should be considered.

A1.4.6 A lightweight and flexible 5G satellite base station (China)²¹¹

In the first half of 2024, the total loss caused by natural disasters worldwide reached USD 120 billion²¹², significantly exceeding the average level of the past ten years. In the future, as the global climate environment deteriorates, the frequency of extreme weather and disasters will continue to increase year by year. Emergency communications have become an important element in the entire process of disaster relief. Traditional emergency communication equipment, such as emergency communication vehicles, are often limited by road conditions, and it can be difficult to ensure emergency support under extreme "no road, no network, no electricity" conditions. In such cases, emergency communication vehicles may be unable enter the target area and base stations cannot be connected. Traditional satellite stations usually rely on traditional geostationary Earth orbit (GEO) satellites, and most of these systems only support Wi-Fi services. In addition, the overall weight of associated traditional devices often attains 50 kg and only external power supply sources are supported. Consequently, two separate enclosures may be required for an installation, making transportation and complex logistics impractical.

Lightweight integrated 4G/5G satellite base station: Lightweight integrated satellite base stations can realize not only Wi-Fi, but also 4G and 5G base stations, through high-throughput satellites. Because the system comprises a built-in battery, the built-in base station can be activated anytime and anywhere. It can also be packed into a backpack, and a single person can carry it to the disaster site. The system can support extreme conditions, and its base station supports up to 400 concurrent users via satellite back transmission. The wide coverage of the base station can provide a convenient and fast access service. Figure A-39 shows the lightweight integrated satellite base station.

²¹¹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0413/> from China Mobile Communications.

²¹² https://www.munichre.com/content/dam/munichre/mrwebsitespressreleases/MunichRe-NatCat-HY-2024-Factsheet.pdf/_jcr_content/renditions/original./MunichRe-NatCat-HY-2024-Factsheet.pdf

Figure A-39: Image of lightweight integrated satellite base station



Key features of the system include:

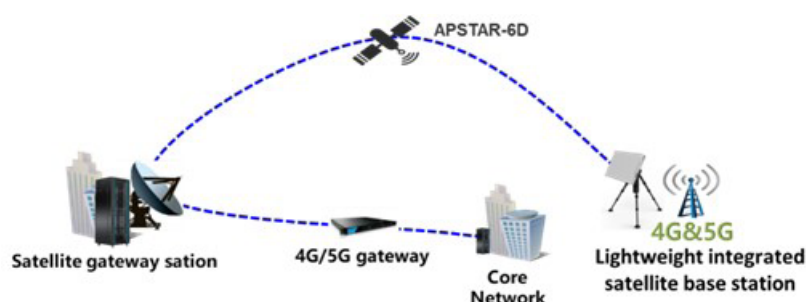
- Reduced weight: 13 kg, with a volume reduction of one-third.
- Enhanced intelligence: designed as a single unit that eliminates assembly requirements (the system previously comprised six separate components).
- Broader compatibility: supports both 4G and 5G networks (previously limited to only 4G).
- Increased transmission power: delivering 1W per channel.
- Extended battery life: high-density batteries provide up to four hours of service.

Other essential performance metrics include:

- Capacity for mobile phone users: 400 users.
- Coverage radius of the base station: 500 metres.
- Operating frequencies for the base station: FDD LTE at 1800 MHz for 4G and 2.6 GHz for 5G.
- Satellite transmission rate: uplink rate of 20 Mbit/s (12 MHz bandwidth), downlink rate of 40 Mbit/s (20 MHz bandwidth).

Technical principle of lightweight integrated 4G/5G satellite base station: The lightweight integrated satellite base station is transmitted using the APSTAR-6D high throughput satellite. After the transmission data is connected to the satellite gateway station, it is connected to the operator network through a transmission line or 4G/5G Internet gateway, thus realizing the operational deployment of the base station. Unlike traditional satellites, high-throughput satellites (HTS) use multi-point beam technology and frequency multiplexing, to significantly increase the overall communication capacity with the same spectrum resources. This system achieves several times the capacity of traditional fixed communications satellites and is tailored for broadband applications such as consumer Internet access. Consequently, this satellite solution increases the connectivity capacity of 4G and 5G base stations while ensuring high-speed Internet connectivity.

Figure A-40: Connection between lightweight integrated satellite base station and core network through HTS



Optimization of satellite transmission for 4G/5G base station. Compared with ground transmission, disadvantages of satellite link include large delay, relatively high channel error rate, and limited transmission capacity which has a greater impact on 4G/5G base stations and user experience. Satellite transmission systems need targeted optimization.

Current satellite transmission systems are unable to provide higher capacity than optical transmission networks, and so they are unable to reach the peak transmission rates of 4G/5G base stations. 4G/5G based on satellite transmission will inevitably encounter the problem of limited transmission capacity. Transmission data includes signalling, various service data, and base station network management data. In order to ensure efficient network operation when the 4G/5G network is overloaded or congested, a quality of service (QoS) mechanism must be used to ensure that important traffic is not delayed or discarded. The QoS mechanism is based on the protocol, virtual local area network identification (VLAN ID), TOS value, source IP address (or subnet), destination IP address (or subnet), port, and differentiated services code point (DSCP), and is independent of the 4G/5G system as an auxiliary QoS mode, which can be combined with the satellite bandwidth allocation mode. The satellite system can know various service priority labels in advance according to QoS rules. On the other hand, the satellite system can also conduct in-depth detection of data in general packet radio service tunnelling protocol (GTP) packets through optimization equipment.

Application case: In August 2023, the north of China experienced unprecedented heavy rainfall due to 'Super Typhoon Doksuri,' which had a profound impact on remote mountainous regions as well as in extensive plains areas. Access to the affected zones was severely hindered for vehicles, leading to significant communication disruptions across most locations. To address the urgent communication challenges, 27 portable satellite stations, transported by emergency telecommunications personnel to the site were deployed, and connectivity was successfully restored in ten towns²¹³. The lightweight integrated satellite base station effectively mitigated the transport and communication barriers caused by the disaster.

A1.4.7 A case study of disaster preparedness by mobile operators in Japan (NTT Docomo)²¹⁴

Japanese mobile communication carriers have established policies for implementing disaster prevention operations to ensure communication services even in the event of a disaster, and have taken measures to prepare for disasters. This section outlines the disaster preparedness of NTT DOCOMO, one of the major mobile operators in Japan.

Applying the three principles of disaster preparedness to secure communications in times of disaster: Since its founding, NTT DOCOMO has been continuously working to secure communications during disasters in accordance with its three principles of disaster preparedness:

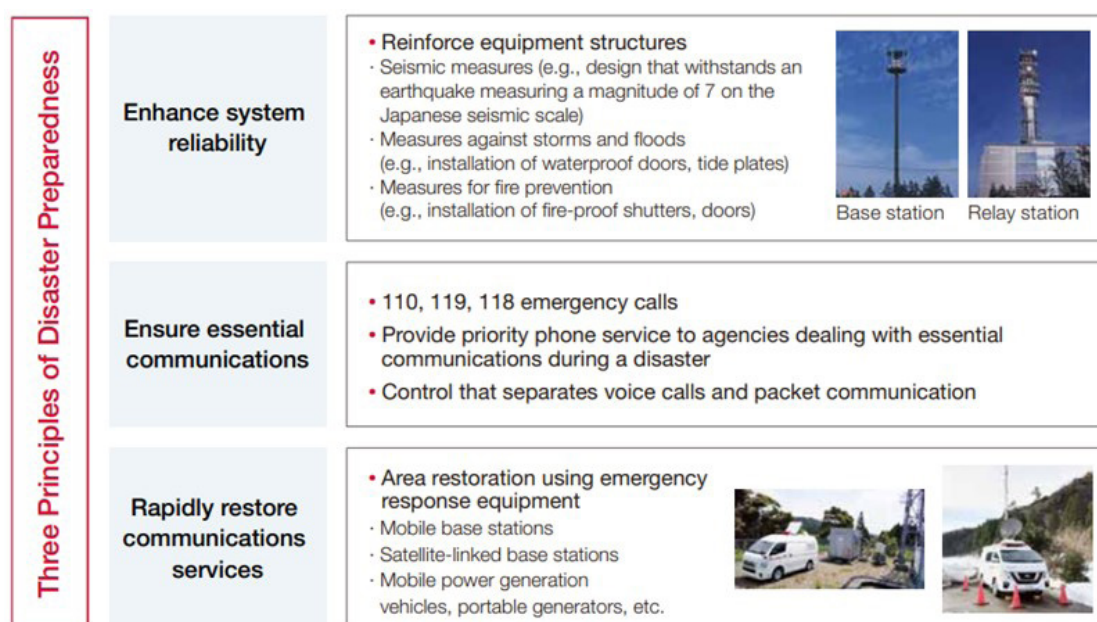
²¹³ <https://mp.weixin.qq.com/s/wEdiyoyzRyfxoXQUxjNJbQ>

²¹⁴ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0412/> from NTT DOCOMO, Japan.

- enhance system reliability,
- ensure essential communications, and
- rapidly restore communications services.

Applying lessons learned from the Great East Japan Earthquake, NTT DOCOMO formulated new measures for disaster preparedness and had implemented these new measures by the end of February 2012. NTT DOCOMO is strengthening its disaster preparedness in order to be better able to respond to the increasingly diverse natural disasters anticipated in the future.

Figure A-41: Three principles of disaster preparedness



Use of emergency base stations in response to the magnitude of a disaster: NTT DOCOMO maintains emergency base stations to secure its networks in the event of a disaster. Depending on the level of damage, NTT DOCOMO implements measures such as setting up temporary base stations and remotely adjusting the transmission angle of radio waves from base stations.

Large-zone base stations: Large-zone base stations are specialized for emergencies to secure communications in heavily populated areas during widespread disasters and power outages. Large-zone base stations provide 360-degree coverage across a seven-kilometre radius, which is wider than that of a standard base station. Since 2011, NTT DOCOMO has installed large-zone base stations at 106 locations around Japan, and all are compatible with long term evolution (LTE) technology, which can enable an approximately three-fold boost in capacity. During the Hokkaido Eastern Iburi Earthquake, which struck in September 2018, NTT DOCOMO activated a large-zone base station for the first time, helping to restore communications to a wide area at Kushiro City.

Figure A-42: Large-zone base station

Medium-zone base station: Medium-zone base stations are built with foundations that are more robust than those of standard base stations and are used as standard base stations under normal circumstances. They are able to cover adjacent areas by remotely expanding their service areas in the event of a disaster-related service interruption at neighbouring base stations. NTT DOCOMO has installed more than 2 000 medium-zone base stations in Japan to cover areas expected to suffer damage based on hazard maps. NTT DOCOMO also promotes the nationwide deployment of medium-zone base stations to secure a means of communication in the suburbs of medium-size cities, disaster base hospitals, and coastal and mountainous regions. 62 base stations were activated during the torrential rains of July 2020.

Covering areas that are difficult to access rapidly. To diversify emergency recovery options in times of disaster, NTT DOCOMO is building shipboard base stations and fixed-line drone base stations that can be used to rescue people living in areas that are difficult to access rapidly from maintenance sites. Following the Noto Peninsula Earthquake on New Year's Day 2024, NTT DOCOMO became the first company to operate a shipboard base station. In cooperation with KDDI Corporation, NTT DOCOMO provided relief to two areas in Wajima City that were severely damaged. In cooperation with related organizations, NTT DOCOMO implemented a sea route approach with the cooperation of the Self-Defence Forces to restore communication in areas where land routes were closed. Drone relay stations also authorized to secure communication areas by amplifying radio waves in airspace and so strengthening the emergency recovery system.

Response to the Noto Peninsula Earthquake. When the Noto Peninsula Earthquake struck on New Year's Day 2024, up to 260 base stations experienced service interruptions due to power outages and transmission line disruptions. Service coverage dropped to 30 per cent of the normal coverage of the six affected municipalities (Nanao City, Suzu City, Wajima City, Shiga-cho, Anamizu-cho, and Noto-cho). NTT DOCOMO established an internal system immediately after the disaster, and began recovery activities the following day. A total of 10 000 staff members engaged in emergency response activities. In addition to road traffic congestion and the long-distance travel imposed by the limited transportation routes on the peninsula, other obstacles to local access included aftershocks and snowfall. In total, more than 200 sites were temporarily restored through restoration work carried out by employees from all over the country. With the help of shipboard base stations, emergency restoration was completed, excluding some areas that were difficult to access, by 17 January, and the area restoration, excluding Hegura Island in Wajima City, was completed on 21 March. NTT DOCOMO also made direct visits to almost all of the designated and undesignated evacuation centres, in approximately 300 locations, and provided free battery charging, free Wi-Fi, and free rental of NTT DOCOMO public mobile phones to evacuees. It also provided mental and physical care by providing online medical care and video services as support for prolonged evacuation centres. This was the first attempt by NTT DOCOMO to provide support for NTT DOCOMO public mobile phones, online medical care, and video services.

A1.4.8 Leveraging CB for public awareness via a CAP platform (India)²¹⁵

SAmekit CHETavani Tantra (SACHET) CAP based early warning dissemination system

- The Pan-India implementation of the CAP-based early warning dissemination system project commenced in August 2021, successfully concluding in August 2023. The primary focus was on developing an indigenous system for early warning dissemination.
- This system plays a crucial role in saving lives and minimizing property damage during disasters.
- Involves the integration of all alert generating agencies, including the Indian Meteorological Department (IMD), the Central Water Commission (CWC), the Indian National Centre for Ocean Information Services (INCOIS), and the Forest Survey of India (FSI).
- Major alert disseminating agencies, such as telecommunications service providers (TSPs), television and radio stations, railways station announcement systems, and coastal alert systems, are being consolidated onto a single platform. TSPs are already connected on CAP-SACHET, and proof of concept (POC) has been completed for all other modes.
- All alert authorizing agencies, including the Ministry of Home Affairs, the National Disaster Management Authority, and the State disaster management authorities (SDMAs) of all 36 States, have been seamlessly integrated. All SDMAs can send geo-targeted alerts directly without manual intervention through their dashboards.
- To date, over 13.50 billion targeted SMSs have been sent by SDMAs using this platform during various emergencies, including the COVID-19 pandemic, and other disasters.

Leveraging cell broadcast (CB) for public awareness via the CAP platform: Following on from the successful implementation of a system for alert dissemination through SMS, the decision was taken to further improve disaster awareness through the development of a CB based emergency alerting system, for sending alerts for disasters that have no, or a very sudden or short lead time. This system allows the dissemination of critical and time-sensitive disaster management information to mobile devices within specified geographical areas. This system was designed in India, and is currently undergoing comprehensive testing. During Cyclone Michaung, alongside SMS dissemination, CB through the CAP platform, emerged as another powerful tool for public awareness. While both systems offer significant advantages, CB presents unique capabilities for reaching larger audiences during disaster situations.

Strengths of cell broadcast via CAP

- **Universal reach:** CB bypasses individual phone subscriptions, directly addressing all phones within a targeted cell tower coverage area. This ensures that even those without an active phone plan receive critical information.
- **Targeted dissemination:** Similar to SMS via CAP, CB allows geo-targeting based on cell tower locations, ensuring relevant alerts reach only those in the path of the disaster event.

²¹⁵ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0207/> from India.

- High penetration: CB messages automatically appear on phone screens, regardless of the user's activity or currently opened app, reaching them even if they are not actively using their phone.
- No action required: Unlike SMS, receiving CB messages requires no user action, reducing the risk of missed information due to unread messages.
- Cost-effectiveness: The cost of CB for emergency alerts is typically borne by mobile network operators, making it a resource-efficient option for large-scale communications.
- Fastest medium: CB can deliver warnings to users within ten seconds.

Steps taken for implementation of alert dissemination through CB

- CB has been implemented among all TSPs and large-scale testing exercises have been conducted in various regions of the country.
- A gazette notification was issued on 6 April 2023, mandating the inclusion of essential features for receiving CB alerts on mobile handsets, encompassing distinct sounds, and storage capabilities, effective six months from the date of gazette publication. Furthermore, the same gazette notification also prescribed the introduction of automatic readouts in both English and Hindi.
- Comprehensive large-scale testing of CB, covering the entire State, was successfully conducted by Pan-India, and was completed by 31 October 2023.

Guidelines on utilizing CB for effective disaster awareness

- Timely warnings: Leverage CAP integration to trigger immediate CB alerts based on real-time storm data and evacuation orders.
- Clear and concise messages: Use simple language and actionable instructions such as information on evacuation zones, shelter locations, and emergency contact details.
- Repetitive broadcasts: Repeat crucial information at regular intervals to ensure it reaches even those initially unavailable or distracted.
- Post-disaster updates: Utilize CB for post-disaster communications, providing essential information on restoration efforts, safety protocols, and recovery resources.

Existing CAP-compliant platforms can be integrated with CB infrastructure, enabling:

- Automated CB activation: Pre-defined triggers based on cyclone severity and location automatically activate CB broadcasts in affected areas.
- Dynamic content management: Updating of message content in real-time based on evolving weather conditions and disaster response needs.

Additional considerations

- Testing and training: Regularly test CB functionality and train emergency personnel on its effective use during disaster situations.

- **Public awareness and education:** Educate the public about CB functionalities and how to respond to disaster alerts received through CB.
- **Collaboration with mobile network operators (MNOs):** Ensure close collaboration with mobile network operators for smooth integration and efficient CB delivery during emergencies.
- **By effectively utilizing CB alongside SMS dissemination via CAP platforms,** disaster response efforts can be significantly enhanced, empowering communities to be better prepared and respond effectively during disaster events.

Conclusion: CB, paired with CAP platform integration, offers a powerful tool for comprehensive public warning awareness during disaster events with a relatively short alert window. The universal reach, targeted dissemination, and automatic nature of CB via CAP can ensure critical information reaches everyone in affected areas, potentially saving lives and minimizing disaster impact. The effectiveness of CB via CAP was successfully demonstrated during Cyclone Michaung.

A1.4.9 The role of satellite communications in disaster communications technologies (SES World Skies)²¹⁶

Natural and man-made threats to communication networks. Natural disasters driven by climate change are intensifying in frequency and severity. For instance, in 2023 alone, Asia experienced 79 hydro-meteorological hazard events, making it the most disaster-hit region in the world.²¹⁷ As seen in natural disasters of the past, profound disruptions can spread across any industry or government sector, not to mention the difficulty natural disasters can present when disseminating life-saving information, coordinating relief efforts, and maintaining public safety. The possibility that terrestrial networks and undersea cables might be affected by natural disasters needs to be taken into consideration. This consideration is even more pronounced for geographically challenging regions such as island and mountainous areas. Amid unpredictable climate conditions, the bolstering of network infrastructure and implementation of reliable fail-safe systems have become indispensable to network planning.

Apart from intense weather, human activities such as dragged ship anchors and fishing-net trawling incidents continue to jeopardise undersea fibre-optic cables that carry 90 per cent of the world's global data.²¹⁸ Very recently, 25 per cent of data flowing between Asia and Europe was disrupted after undersea cables in the Red Sea were severed.²¹⁹ The vastness of oceans and frequently harsh conditions may often obscure the exact causes of disruption, making preventative measures difficult to implement. Untimely disruptions can greatly impact critical sectors such as finance, commerce, transportation, and healthcare that rely on constant connectivity. In 2017, heavy tropical storms between Singapore and Perth cut the SEA-ME-WE3 cable linking Europe, the Middle East region, and Asia disrupting communications for over a month.²²⁰ In 2022, an underwater volcano severed

²¹⁶ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0421/> from SES World Skies.

²¹⁷ Climate change and extreme weather impacts hit Asia hard. (2024, April 23). World Meteorological Organization. <https://wmo.int/news/media-centre/climate-change-and-extreme-weather-impacts-hit-asia-hard>.

²¹⁸ Tratos Group. (n.d.). What are submarine cables used for? Tratos Cable Academy. <https://tratosgroup.com/tratos-cable-academy/what-are-submarine-cables-used-for/>.

²¹⁹ BBC News. (2023, October 2). Internet outages: Undersea cables damaged in Middle East region <https://www.bbc.com/news/world-middle-east-68478828>.

²²⁰ DatacenterDynamics. (2017, August 31). SEA-ME-WE 3 cable cut by storms. DatacenterDynamics. <https://www.datacenterdynamics.com/en/news/sea-me-we-3-cable-cut-by-storms/>.

Tonga's international and domestic cables, and took 18 months to be fully repaired.²²¹ In the face of such natural or man-made disasters, the ability to sustain communication saves lives and supports mission-critical disaster recovery efforts. This is where satellites play a crucial role.

Resilient networks - How communications satellites mitigate the impact of disasters on connectivity: Communication network solutions must be adaptable and reliable in order to mitigate unpredictable threats. Powered by SES geostationary (GEO) and medium Earth orbit (MEO) high-throughput satellites, the end-to-end network acts as a life-saving conduit during times of disaster. The uninterrupted support of satellites, both MEO and GEO, enables emergency responders to carry out their jobs expeditiously and reliably, especially when terrestrial networks are damaged or out of service. Positioned 8 000 km above sea level, MEO satellite constellations such as SES O3b and [O3b mPOWER](#) provide low-latency and high-throughput connectivity across vast regions. This allows businesses to reroute traffic and keep essential services running even when terrestrial infrastructure is compromised. GEO satellites, positioned 36 000 km above sea level, provide a critical layer of redundancy, enabling broad, dependable coverage for essential services such as weather monitoring, broadcasting, and emergency communications. The O3b satellite service was deployed in Tonga in 2024, after [SES extended its Digicel Partnership](#) in a bid to enhance disaster network resiliency of the Pacific nation. The MEO satellite powered network enabled rapid recovery of voice, SMS, and data services just six hours after Tonga's only subsea cable was severed. Tonga had also suffered from a previous major connectivity disruption after the Hunga Tonga-Hunga Ha'apai volcanic eruption in 2022, and [relied on GEO satellites](#) to maintain island connectivity as undersea cables were restored. In another instance in Taiwan, a private 5G network platform deployed on a mobile truck along with [SES O3b MEO terminal technology allowed the delivery of 5G services](#) to enable emergency response teams to coordinate rescue efforts.²²² When terrestrial networks are down O3b mPOWER can also support live mobile video capture and video surveillance, which are critical capabilities that enable rescuers to successfully facilitate response efforts. Together with the Government of Luxembourg, and through the [emergency.lu](#) solution, a provider of end-to-end solutions for rapid emergency telecommunication service recovery, SES World skies has [delivered vital connectivity services](#) in the aftermath of disasters when telecommunication infrastructure and terrestrial wireless systems have been disrupted or destroyed.

Hurricane Beryl, was the strongest hurricane in history to form in the month of June in the Atlantic Ocean, and wreaked havoc as it swept through Grenada, Saint Vincent and the Grenadines, and Jamaica. Initially a tropical depression, Beryl rapidly intensified into a Category 4 hurricane and briefly reached Category 5 status, with winds up to 240 km/h (150 mph). 'Emergency.lu solution' along with a humanitarian intervention team were sent to assist the populations in need on the islands of Grenada, and Saint Vincent and the Grenadines. The Beryl mission involved a Ku-band satellite terminal, which was initially deployed on Carriacou Island and that was subsequently moved to Union Island. The Ku-band satellite terminal used the SES-14 satellite for communication, to establish and maintain contact with the affected country, the humanitarian community, and the media, as well as to access vital information and coordinate the emergency response.

Conclusion: Network deployment, maintenance, and recovery operators can further bolster network redundancy and resilience by incorporating multi-orbit satellite communications systems. With MEO and GEO, maintaining reliable communications becomes possible for urban centres, remote rural regions, and everywhere in between. The efforts of SES in restoring connectivity after several natural disasters showcase how satellite systems can effectively restore services quickly.

²²¹ Paul Lipscombe. (2024, July 11). Tonga's only domestic subsea cable suffers another outage, could take weeks to repair. DatacenterDynamics. <https://www.datacenterdynamics.com/en/news/tongas-only-domestic-subsea-suffers-another-outage-could-take-weeks-to-repair/>.

²²² Taiwan Taps Private 5G for Disaster Recovery, SES, 14 September 2022.

A1.5 Network resilience

A1.5.1 Use of telecommunications/ICTs for disaster risk reduction and management (RIFEN)²²³

Telecommunications and ICT have become essential tools in disaster management. These technologies enable the rapid collection, transmission, and analysis of critical data, facilitating real-time decision-making. However, despite their potential, challenges persist. Access to technologies remains uneven, especially in regions most vulnerable to disasters. In addition, coordination between different stakeholders, including governments, NGOs, and the private sector can be difficult to establish in emergency situations. Finally, the resilience of telecommunications infrastructures to disasters is a major concern. A number of solutions and improvements are outlined in this section.

Integration of emerging technologies: This improvement involves including the use of emerging technologies such as artificial intelligence (AI) and the Internet of Things (IoT) in data analysis and real-time decision-making during disaster situations. AI can be used to analyse large quantities of data from a variety of sources, such as social networks, environmental sensors and surveillance systems, to quickly detect emerging trends and risks. Similarly, IoT enables real-time data collection from connected sensors and devices, providing greater visibility into conditions on the ground.

Development of robust communication platforms: This enhancement aims to develop robust and accessible communication platforms to facilitate coordination between the various stakeholders involved in disaster management. Robust communication platforms could include centralized emergency information management systems that enable the secure sharing of data between government agencies, humanitarian organizations, businesses, and citizens. In addition, user-friendly mobile applications could be developed to provide real-time alerts, information on emergency shelters, evacuation routes, and available rescue services.

Enhancing the resilience of telecommunications infrastructures: This improvement involves investing in innovative solutions to strengthen the resilience of telecommunications infrastructures in the face of disasters. This could include the deployment of deployable mobile networks, such as base stations on wheels or drones equipped with communication relays, which can be rapidly deployed in disaster-affected areas to restore communications. In addition, low-energy wireless communication technologies, such as long range wide area networks (LoRaWAN), could be deployed to provide backup connectivity in areas where traditional infrastructure has been damaged.

Conclusion: In conclusion, the use of telecommunications and ICT offers considerable potential for building resilience to disasters. However, to fully exploit this potential, it is essential to overcome the challenges of accessibility, coordination, and infrastructure resilience. The recommendations set out in this report offer ways of overcoming these challenges and improving communities' ability to deal with disaster risk proactively and effectively. By implementing these recommendations, stakeholders will be able to make better use of information and communication technologies to save lives, reduce economic losses, and foster community resilience to disasters.

A1.5.2 ICT infrastructure and network resilience assessment: An approach for emergency telecommunications (Haiti)²²⁴

Following the earthquake on 14 August 2021, that devastated southern Haiti, ITU again volunteered, as it had done on 12 January 2010, and following the hurricane of 4 October 2016, to assist in the provision of personnel and equipment to facilitate communication for the management of rescue and

²²³ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0197/> from Réseau International des Femmes Expertes du Numérique (RIFEN).

²²⁴ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0129/> from Haiti.

relief operations and recovery. Initiated in October 2020, in response to the COVID-19 pandemic, to help countries to strengthen digital infrastructure and ecosystems and to remain resilient in the event of natural disasters, the Connect2Recover initiative was implemented in the country and served as a precursor to the contribution of ITU in assessing the resilience of telecommunication networks and infrastructure of Haiti.

Why assess the resilience of telecommunication networks and infrastructure: Telecommunication/ICT infrastructure is essential to the functioning of society today. Services provided by these networks and infrastructure are essential to almost all vital sectors: education, economy, healthcare, finance, commerce, and transport, etc. Failure in the provision of such services can bring the operation of those sectors to a halt, resulting in huge losses in both time and money. Another important point is that, in the event of disasters, a natural reflex is to use telecommunication/ICT services to enquire about the survival, health or mental well-being of loved ones. Determining whether networks and infrastructure can withstand a disaster is crucial.

The assessment and its implications: Conducted by a local expert, the assessment took into account the existing situation to verify resilience according to a restoration plan. Monitoring will involve the collection of relevant data from telephone network operators and Internet access providers via an appropriate questionnaire. Further information on the needs and challenges of operators and suppliers was gathered in separate interviews. In addition, there was an analysis of available broadcasting data collected during interviews with station chief engineers, and connectivity measurements for rural populations carried out in the field.

The results of the assessment, based on the acquisition, collection, analysis and interpretation of data are as follows:

- 60-75 per cent variation in the overall recovery or rebuilding capacity for mobile phone operators and the main Internet access provider;
- 60-80 per cent variation in overall market resilience;
- Low level of connectivity in rural areas (reliance on 90 dBm signal);
- Predominance of 2G in rural areas and very low broadband penetration;
- Means of repairing infrastructure damaged by a disaster for broadcasting stations is generally low (less than 10 per cent), thus very low overall resilience.

Resilience implies the ability of networks and infrastructure to react or adapt to sustain services in the event of disasters. This depends on the quality of the equipment and architecture that make up the networks and infrastructure, which requires a distinction to be made between active resilience (capacity to react or adapt) and passive resilience (relating to equipment and architecture). The assessment carried out by the local expert calls for operators and service providers to have a redundancy strategy in improving their existing architecture.

The results of the assessment will guide decision-makers and stakeholders in taking measures to consolidate recovery capacity and the existing resilience level. These measures must include, in particular, resilience to future disasters. Working to mitigate damage and ensure adequate infrastructure and network availability before, during and after disasters is essential.

Consideration of assessment by stakeholders: As a follow-up to the telecommunication network and infrastructure resilience assessment, a feedback workshop was held with stakeholders (ITU and CONATEL), the Government of Haiti, operators and service providers, the university, and other telecommunication sector actors. This led to recommendations for network and infrastructure resilience. The Government has written to CONATEL congratulating it and asking it to express its thanks to ITU for this noble initiative. To this end, the Minister of Public Works, Transport and Communications

required the formation of a follow-up group to take into account the recommendations of the workshop. This follow-up group will consist of two commissions, one working on resilience, taking into account the expert's recommendations, and the other on emergency telecommunications.

Conclusion: As discussed previously the use of telecommunications/ICTs for disaster risk mitigation and management went some way to avoiding exposing people to risk of infection through their repeated attendance at COVID-19 testing centres and healthcare centres, and also because the use of telecommunications/ICTs also helps in management before, during and after natural disasters, ensuring network and infrastructure resilience is vital for protecting property and saving lives.

A1.5.3 Resilience of telecommunication/ICT networks and infrastructure in Haiti²²⁵

Any failure in the provision of services can disrupt the continuity of services offered to communities, consumers, government and the private sector, resulting in, at the very least, substantial losses in time and money. Today, disruptions in the provision of telecommunication/ICT services can have just as much impact as a power outage, interrupting the provision of essential services to citizens and impacting their lives and livelihoods. When a disaster strikes, the first reaction of individuals everywhere 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 ensure a rapid return to normal life. The consequences when the telecommunication networks themselves are affected and users are left without service in an emergency can be extremely serious. In view of the essential role that telecommunication networks play for users in both normal and disaster situations, there is a clear need to protect these networks and their infrastructure so as to ensure their continuous, uninterrupted availability at all times. Like any system, telecommunication networks are exposed to a variety of threats:

- **Malicious attacks:** cable theft, signal jammers, cable damage and anti-satellite weapons;
- **Non-deliberate threats:** system failures, power failures, and cable damage;
- **Natural hazards:** hurricanes, earthquakes, flooding, and tsunamis.

When a disaster occurs, telecommunication networks and infrastructure may suffer the physical destruction of network components, disrupting the support infrastructure, and causing network congestion. In order to be able to withstand damage and to continue to ensure an acceptable level of service, telecommunication systems need to be resilient against all kinds of threats.

Natural disasters in Haiti: Haiti is no stranger to natural disasters: tropical storms, tropical waves, and hurricanes are all common occurrences. The country is also vulnerable to droughts, torrential rains, flooding, landslides and occasional earthquakes. On 12 January 2010, a major earthquake resulted in some 220 000 deaths and 300 000 people injured, and destroyed much of the country's infrastructures. On 4 October 2016, a category 4 hurricane, hurricane Matthew, struck Haiti with high winds, flooding in coastal regions, and heavy rains. The southern part of the country was particularly afflicted by the resulting massive floods and landslides. There was widespread damage to infrastructure, agricultural crops and natural ecosystems, and the death toll reached 546. Another earthquake, this one of magnitude 5.9, struck on 6 October 2018, in the zone 20 km north of Port-de-Paix in the northwest of the country. It affected several departments, and resulted in 12 deaths and 151 injured. On 14 August 2021, an earthquake struck southern Haiti, leaving 2 248 dead, 12 763 injured and 329 missing, according to the National Emergency Operations Centre. The economic damage has been estimated at USD 1.5 billion. The earthquake directly or indirectly affected 690 000 people, or 40 per cent of

²²⁵ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0165/> from Haiti.

the population of the departments of Nippes, Grand'Anse and Sud. In addition to the loss of life, 83 770 houses were damaged, and a further 53 815 were completely destroyed.

Figure A-43: Region affected by the 14 August 2021 earthquake



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.

Department	Nippes	South	Grand'Anse
Population	342 325	774 976	468 301
Area (km ²)	1 268	2 654	1 912
Municipalities	11	18	14
Density (inhabitants/km ²)	246	266	245

Source: 2023 study of telecommunication network resilience in Haiti.

Telecommunications in Haiti. The telecommunication sector of Haiti is organized on three distinct levels: policy, regulation, and the market. The public policy of the Government with its plans and vision for the sector, falls within the responsibility of the Ministry of Public Works, Transport and Communications (Ministère des Travaux Publics Transports et Communications, MTPTC). Regulatory matters are the responsibility of the National Telecommunication Council (Conseil National des Télécommunications, CONATEL), which was founded on 27 September 1969, and reporting is the responsibility of the MTPTC. The regulatory remit of the MTPTC is set out in the 12 October 1977 decree, covering licences, concessions, authorizations, and so on. As for the communications market, it is dominated by two mobile telephony operators, four Internet access providers, some 347 FM radio broadcasting stations, 131 terrestrial television stations, and four satellite broadcasters.

The telecommunication infrastructure and market in Haiti. With a penetration rate of 65 per cent, cellular telephony dominates the Haitian telecommunication market, and the Internet penetration rate is also growing, despite the challenges posed by the risk of natural disasters in the country. Fixed connections lag far behind wireless. In terms of infrastructure, the country uses:

- radio relay links (in cooperation with Dominican Rep.);
- satellite links; and
- submarine cables (the Haiti-Bahamas cable, the Columbus cable from the United States, and the Claro cable from Dominican Rep.).

Currently international access is diversified in the telecommunications market of Haiti, and consists of submarine cables (BaTelCo and Columbus); an underground cable (with Dominican Rep.); several radio relay links (with Dominican Rep.); and several satellite links, mainly used 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. Accordingly, it is not possible to establish accurately the total number of international gateways.

Evaluation of damage to telecommunication networks: failures during disasters. In general terms, a telecommunication network becomes dysfunctional when one or more components are in total or partial failure due to a breakdown caused by a disaster of natural or human origins. The affected key part or component of the network or infrastructure causes a technical malfunction in the system. The

failed component may affect one part of the system or the entire system, with the undesired result that service becomes unavailable. The failures of a telecommunication network or infrastructure caused by a disaster vary depending on the cause. The failure of a telecommunication system can be caused by any of three primary causes:

- physical destruction of network components;
- disruption in the supporting network infrastructure; and/or
- network congestion.

Information on network damage is obtained from reports to the regulator. An assessment of the existing network restoration plan and the current level of network resilience was conducted by ITU and CONATEL on the basis of data collected from mobile network operators (MNOs) and Internet access providers (IAPs) through a questionnaire. The additional information received, and the identified challenges and needs of the MNOs and IAPs provides an idea of their post-disaster recovery capabilities. An assessment of the broadcasting subsector through analysis of the available data, also provided information on the state of the subsector and its capabilities. Field visits were carried out to help assess the level of connectivity of rural populations. In terms of resilience, it was determined that the overall recovery or reconstruction capability of the mobile telephone operators and the main Internet access provider in Haiti, is between 60 and 75 per cent. Other findings from the assessment of network resilience in Haiti included the following:

- the overall resilience of the Haiti telecommunication market is between 60 and 80 per cent;
- in rural areas, the level of connectivity is low, and most connections depend on a signal having a strength of -90 dBm;
- 2G is still predominant in rural areas, so the penetration of high-speed Internet remains very low;
- less than 10 per cent of radio and television stations have the means to repair infrastructure damaged in a disaster;
- the overall resilience of radio and television stations is very low.

The passive resilience of telecommunication networks and infrastructures depends on equipment and architecture, while active resilience depends on an ability of the operator to react or adapt. It is important to emphasize that the quality and type of equipment must be guaranteed by manufacturers. While the network redundancy strategy is mainly the responsibility of the service providers/operators, there is also a need to improve the existing network architecture, especially in terms of route diversity. In the first instance, the results of this assessment will help decisionmakers and stakeholders in the actions they undertake to reinforce the existing recovery capabilities, and the level of resilience. They should also take appropriate measures to increase their recovery capabilities, and in particular strengthen their resilience to future disasters. The ongoing network recovery and resilience building projects of the regulator and the telecommunication operators should give a significant boost to the development of the sector in Haiti. In this context, it is fundamental and rational to take the following steps to ensure that telecommunication networks do not suffer excessive damage, and that availability is not unduly impaired in a disaster and its aftermath:

- assessment of the impact of damage incurred by telecommunication networks and infrastructure;

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

A1.5.4 Enhancing disaster resilience through telecommunications and ICTs in disaster prone areas (Intelsat)²²⁶

Statement of the situation or problem: Telecommunications and ICTs play a crucial role in disaster mitigation, preparedness, response, and recovery. For instance, countries bordering the Pacific Ocean, in the Southeast Asia or Caribbean regions, witness significant disaster events annually, demonstrating the critical need for resilient disaster communications and management systems in these vulnerable regions. By harnessing technological advancements, disaster prone countries can bolster their preparedness, response, and recovery efforts. Resilient communication infrastructure, including satellite networks, ensures continuous connectivity during emergencies, facilitating coordinated response efforts. Strengthening the capacity of local institutions through training programmes and fostering partnerships with regional stakeholders further enhances disaster resilience. By integrating telecommunications and ICTs into comprehensive disaster management strategies, disaster prone countries can better protect infrastructure and livelihoods from the impacts of natural disasters. This section addresses efforts that can be undertaken to enhance disaster resilience through telecommunications and ICTs globally, and more specifically in disaster prone regions.

Leverage terrestrial and satellite technologies for disaster resilience: Terrestrial and cable technologies are vulnerable to exposure to natural hazards prevalent in disaster prone regions. Events such as cyclones, earthquakes, and volcanic eruptions pose significant risks to infrastructure components, leading to disruptions in communication networks. Moreover, the remote and dispersed nature of Pacific Island territories poses challenges to the deployment of terrestrial fibre-optic networks across the entire region. Financial constraints further limit the ability of telecommunication service providers to invest in fibre-optic technology, particularly in rural and remote areas. In response to these challenges, there is a growing reliance on satellite networks as vital components of disaster-resilient communication systems. Satellites offer resilience to physical damage, making them ideal for providing crucial connectivity in remote and disaster-prone areas. Satellite broadband networks offer several advantages in disaster scenarios. Portable very small aperture terminal (VSAT) antennas, hand-held terminals, and temporary installations can be rapidly deployed post-disaster to bolster communication efforts. Additionally, satellites equipped with software-defined technology enable dynamic capacity allocation in areas of higher need, enhancing network resilience and supporting emergency response activities. Finally, satellite backhaul solutions play a critical role in ensuring connectivity in remote regions and in serving as backups for critical terrestrial infrastructure. Moreover, in any jurisdiction, such as those in the Pacific region countries that already possess significant satellite antenna infrastructure, this satellite antenna infrastructure can be recommissioned following a disaster with minimal investment to enhance disaster resilience. By leveraging both terrestrial and satellite technologies, disaster resilience and continuity of communication during emergencies can be ensured.

Analysing national experiences and best practices

Capacity building: Governments need to prioritize capacity building initiatives to enhance disaster management capabilities. This involves providing training programmes for local institutions and stakeholders involved in disaster response and recovery efforts.

²²⁶ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0252/> from Intelsat US LLC.

Partnerships and collaborations: Collaborative efforts among governments, regional organizations, NGOs, and the private sector are essential. By fostering partnerships and sharing experiences, best practices, and lessons learned, countries in disaster-prone regions can strengthen their disaster resilience. This collaborative approach also facilitates the exchange of resources, expertise, and technologies to enhance disaster preparedness and disaster response. The role of ITU is also important in this collaboration, not only through capacity building, but also through the ITU Partner2Connect (P2C) initiative, that fosters partnerships and resource mobilization for implementing critical telecommunications infrastructure projects.

Regulatory and policy initiatives

Exemptions and streamlined procedures: Regulatory constraints often hinder the rapid deployment of telecommunications infrastructure during emergencies. Governments should implement exemptions from licensing and customs clearance procedures during disaster situations to expedite the deployment of critical telecommunications equipment and technologies. For instance, exemptions from a local entity requirement or from type approval requirements should be encouraged to ensure a fast deployment of telecommunications infrastructure during emergency situations. Streamlined regulatory processes ensure that telecommunications providers can quickly establish or restore connectivity in affected areas without bureaucratic delays.

Investment incentives: Encouraging investment in resilient telecommunications infrastructure requires creating favourable regulatory environments and offering investment incentives. Governments can provide tax breaks, subsidies, or other financial incentives to telecommunications operators and infrastructure providers willing to invest in disaster-resilient networks. Removing regulatory barriers and offering investment incentives can attract private sector investment in disaster resilient telecommunications infrastructure.

Desired outcome

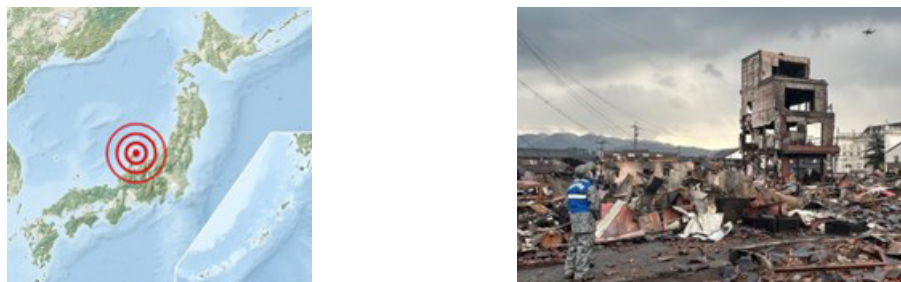
In conclusion, the submission proposes a multi-faceted approach to enhancing disaster resilience in disaster prone regions through telecommunications and ICTs. By leveraging both terrestrial and satellite technologies, countries can overcome the vulnerabilities of traditional infrastructure and ensure continuous communication during emergencies. Capacity-building initiatives, partnerships, and collaboration among governments, regional organizations, and the private sector are crucial for strengthening disaster management capabilities. Regulatory and policy initiatives, including exemptions and streamlined procedures, and investment incentives are essential for encouraging investment in resilient telecommunications infrastructure.

A1.6 Human factors and stakeholder collaboration

A1.6.1 Building resilient infrastructure in Japan - Early recovery response to the Noto Peninsula earthquake (Japan)²²⁷

Noto Peninsula earthquake: At around 4:10 p.m. on 1 January 2024, a powerful earthquake hit the Noto Peninsula area of Ishikawa Prefecture, Japan. The earthquake was registered 7, the highest level on the Japanese seismic intensity scale. The shaking and accompanying tsunami caused widespread destruction on the Noto Peninsula. As of 28 February 2024, there were 241 deaths confirmed and 12 people remaining missing, while nearly 1 300 were injured across eight prefectures, making it the deadliest earthquake in Japan since the 2016 Kumamoto earthquakes.

²²⁷ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0192/> from KDDI.

Figure A-44: Noto Peninsula earthquake

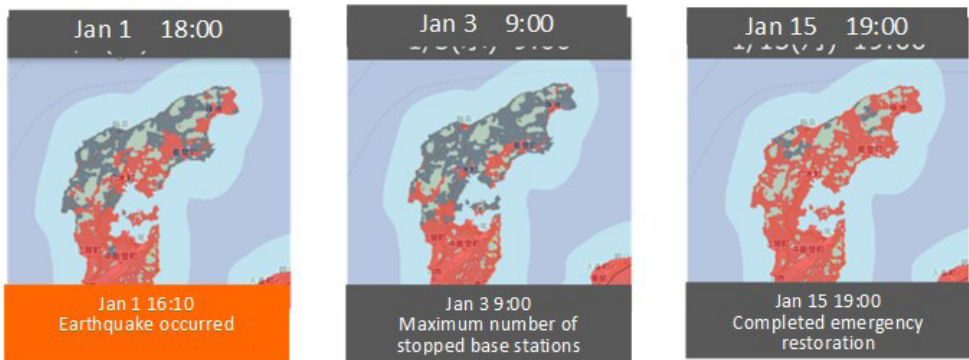
Network recovery status²²⁸ (18 January 2024): Approximately two weeks after the Noto Peninsula Earthquake disaster, on 18 January, the four mobile carriers NTT Docomo, KDDI, SoftBank, and Rakuten Mobile held a joint press conference on the network recovery status in the disaster area. Executives in charge of each mobile carrier network gathered at the conference and explained the recovery status of mobile phone lines in the local area. All four companies had completed 'emergency restoration,' except in some difficult to access areas, and aimed for prompt restoration in the remaining inaccessible areas as soon as roads could be opened. 'Emergency restoration' refers to measures undertaken to temporarily restore network operations, such as "bringing a generator to a base station that cannot operate due to a power outage" or "bringing satellite communication equipment to a base station where the optical-fibre of the transmission line has been cut". The prospect of full recovery depends on the recovery status of related infrastructure in each area, such as roads, electricity, and fibre-optic transmission lines. In areas where the network went down due to the disaster, the majority of the causes were "transmission line breaks due to landslides" and "prolonged power outages". Both issues depend on the restoration status of other infrastructure, so even though emergency restoration had been largely completed, it was difficult to predict when full restoration would be achieved, but it was expected to take a considerable time.

KDDI communication network recovery progress²²⁹ (15 January 2024): As of 15 January 2024, KDDI, with the exception of sites that were difficult to access due to earthquake-related landslides, had completed emergency restoration in areas where communication services were unavailable or difficult to operate, by bringing in mobile base stations (vehicle-mounted or portable base stations) and by installing antennas for satellite broadband at the base stations. In areas with inaccessible locations, KDDI worked in collaboration with local government and related agencies, including the Self-Defence Forces, to prioritize responses to evacuation centres. In addition to the early restoration of communication networks through the installation of mobile base stations and satellite antennas, KDDI also provided communication support such as in the setting-up of satellite communications for free Wi-Fi (also made available to non-KDDI customers) at evacuation centres until the completion of recovery operations. Schools that were used as evacuation centres were also equipped for online classes by satellite.

²²⁸ Network recovery status in the disaster area https://news-mynavi-jp.translate.goog/article/20240118-2865619/?_x_tr_sl=ja&_x_tr_tl=en&_x_tr_hl=ja&_x_tr_pto=wapp

²²⁹ KDDI communication network recovery progress https://news-kddi-com.translate.goog/kddi/corporate/newsrelease/2024/01/16/7186.html?_x_tr_sl=ja&_x_tr_tl=en&_x_tr_hl=ja&_x_tr_pto=wapp

Figure A-45: Communication network recovery



There were a great number of transmission line failures, and due to road closures and landslides, it was not always possible in these places, to carry out transmission line recovery work, or even to bring in mobile base stations (vehicle-mounted or portable). Such conditions added to the time required to restore base stations and connectivity. KDDI worked to achieve a quick recovery of the communication network by using its own disaster response system to visualize the damage situation of the base stations, quickly assess the situation, and formulate a recovery plan. In addition, KDDI worked on recovery activities such as the restoring of communications using a shipboard base station, collaborating with local government to facilitate early road opening, transporting recovery response items to isolated areas in collaboration with the Self-Defence Forces, and installing mobile base stations and satellite antennas for evacuation centres.

Table A-6: Recovery equipment in use (as of January 15, 2024)

Equipment	Number of units
Vehicle-mounted/portable base station	84
Satellite antenna for backhaul lines	159
Portable generators	228
Shipboard base station	1 vessel (NTT Docomo joint)

Figure A-46: Recovery activities

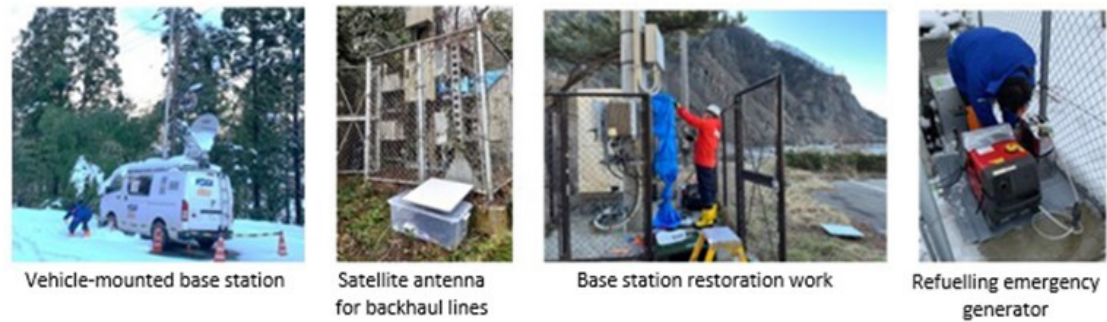


Figure A-47: Support at evacuation centres



Strengthening measures in preparation for large-scale disasters: Given the importance of mobile communications, and especially of mobile phones, which often serve a lifeline during disaster events, it is extremely important to strengthen the disaster resistance of communications infrastructure. In Japan, and particularly since the Great East Japan Earthquake of 2011, mobile phone carriers have been working to strengthen measures against transmission line interruptions, power outages, and equipment failures. Additionally, the Ministry of Internal Affairs and Communications (MIC) has:

- amended relevant ministerial ordinances requiring businesses to strengthen disaster countermeasures,
- deployed mobile power supply vehicles,
- created a response team (MIC-TEAM) that provides disaster response support to secure means of information and communication in the event of a disaster, and
- made it mandatory for mobile phone base stations that cover important locations, such as municipal government offices, to implement preventive measures against power outages, for at least the first 24 hours following a disaster event, to ensure communication during disasters.

In addition, as it is vital to secure a means of communication that enables administrative agencies to operate smoothly even when normal communication services, such as mobile phones, have been interrupted, the MIC has established a satellite mobile phone network. By stockpiling rental radio equipment and deploying it in each region, MIC have established a system to enable lending of satellite mobile phones, etc., to local government during disaster events. Furthermore, in order to secure electricity and fuel, which are important for the early restoration of communication services, MIC are cooperating with related ministries and agencies, in establishing liaison systems and conducting joint training exercises. Telecommunications carriers, the Ministry of Defence, and the Self-Defence Forces have also concluded agreements regarding mutual cooperation in securing communications during disasters, including the implementation of training exercises, the sharing of information important for recovery activities during disasters, and the provision of disaster recovery equipment and supplies. Efforts are also being made to strengthen cooperation regarding the transportation of disaster recovery personnel.

Some examples of disaster preparation activities

- Mobile phone carriers have installed over 800 satellite entrance lines that connect mobile base stations via satellite in the event that terrestrial lines go down. The four mobile phone carriers have over 11 400 time-based base stations (as of the end of March 2023) and over 4 300 mobile power supply vehicles and portable generators for 24-hour backup power.

- The Business Telecommunications Equipment Regulations (Ministerial Ordinance) were revised in 2012, and comprise provisions for strengthening the disaster resistance of transmission line equipment, strengthening power outage countermeasures, and strengthening large-scale disaster countermeasures.
- In response to the widespread and long-term disruption of mobile phone base stations in the Kanto region of Japan due to a power outage caused by a typhoon in 2019, the information and communication network safety and reliability standards (notifications) were revised in 2020. The revised standards require 24-hour backup power for mobile phone base stations that cover municipal offices and recommend 72-hour backup power for prefectural offices, remote islands, and other offices that are difficult to reach.

Early recovery response to the Noto Peninsula Earthquake. In response to the 2024 Noto Peninsula Earthquake, the MIC collaborated with telecommunications carriers, etc., to immediately collect damage information, and dispatched the MIC-TEAM to Ishikawa Prefecture to quickly restore telecommunications services. Regarding mobile phone services, due commercial power outages, equipment failures or damage to base stations, and disconnection of transmission lines, the service coverage area in six cities and towns in the northern part of the Noto Peninsula had been reduced to less than a third of the pre-disaster service coverage area. There were also problems encountered in 70 to 80 per cent of coverage areas. To quickly restore mobile phone services in the face of such damage, the telecommunications carriers installed emergency recovery equipment, such as mobile power supply vehicles and portable base stations. As a result of mutually coordinated efforts, which included coordinating with related organizations for the transportation of fuel and personnel, and in the of clearing roads, the emergency restoration work was largely completed by mid-January, just two weeks after the earthquake. In addition, to ensure a working communications environment at evacuation centres and other locations, the four mobile phone carriers lent approximately 660 satellite Internet devices (Starlink terminals) free of charge, and provided mobile terminals, etc. MIC also provided mobile power supply vehicles and mobile terminals. MIC have also been working on collaborative efforts, such as renting out communication equipment, such as satellite mobile phones. While major roads were cut off by landslides and restoration work was difficult, the preparations and countermeasures that were undertaken by the public and private sectors were put to good use.

Notes

- Approximately 330 power supply vehicles and generators are available for both the public and private sectors. Additionally, each carrier operates approximately 100 in-vehicle/portable base stations.
- Coordination with the Japan Maritime Self-Defence Force enabled the use of transport ships to refuel and transport recovery equipment to difficult-to-reach areas, and coordination with the Ministry of Land, Infrastructure, Transport and Tourism facilitated the road clearance necessary for base station restoration operations.

Prospects for securing communications in the event of future disasters: In response to this disaster, all possible means were mobilized, including emitting radio waves from coastal areas using a ship-based base station, and covering the area with temporary base stations using drone technology. In addition, satellite Internet equipment (Starlink terminals) was widely used as a replacement when the fibre-optic lines to mobile phone base stations were cut off. Satellite Internet equipment was also used to secure a means of communication at evacuation centres. The MIC conducted a study of the causes of the disaster and of its response and took into account the progress made in efforts to utilize new technologies, such as satellite and drone technologies, as well as the progress made in public-private collaboration. Efforts will be made to further strengthen the communication environment so that communication will not be disrupted during future disaster events. MIC aim to introduce "inter-

operator roaming" by the end of 2025, which allows mobile phone users to temporarily use another carrier network in the event of an emergency, such as a natural disaster or communication failure. In recent years in particular, related businesses have also been working towards the commercialization of services that allow smartphones to make calls, and send and receive emails, using satellites and unmanned aerial vehicles in the stratosphere. Utilizing new technology, MIC will also proceed with efforts to ensure that mobile phone services can be used even if base stations are damaged and the terrestrial network is interrupted.

A1.6.2 Strengthening stakeholders and communities' collaboration in disaster risk reduction through radio communication simulations (Indonesia)²³⁰

Indonesia, as part of the so-called Pacific "Ring of Fire", comprises very complex geological conditions and is prone to natural disasters. With more than 130 active volcanoes, Indonesia experiences frequent volcanic eruptions, earthquakes, and tsunamis. In addition, the presence of colliding tectonic plates around Indonesia is also the main cause of seismic activity, which often results in heavy losses in terms of both physical damage and fatalities. Natural disasters often cause deaths and injuries, extensive infrastructure damage, and can severely impact social, economic, and environmental life. Therefore, a thorough understanding of the situation is critical for effective disaster risk management and for building community resilience to natural disasters. Currently, Indonesia has a number of communication channels for disaster management and dissemination, such as SMS Blast, EWS, website, mobile apps, social media, Emergency Service 112, and disaster radio communications.

Telecommunications infrastructure is often damaged and rendered non-functional during disasters, making coordination and rescue difficult. Therefore, it is important to have reliable communication alternatives when the telecommunications network is down. One effective solution is the use of radio frequency (RF) for disaster radio communications. Disaster response agencies often have their own frequency channels for internal coordination that are used when a disaster occurs. This situation can make communication between the various disaster response agencies difficult. MCI²³¹ (DG-SDPPI²³²) has developed an initiative to organize disaster radio communication simulation exercises involving disaster response agencies (BNPB²³³, Basarnas²³⁴, BMKG²³⁵, BPBD²³⁶, BRIN²³⁷), community radio organizations (ORARI²³⁸, RAPI²³⁹) and disaster community activists or volunteers. The simulation exercise includes preparing radio communication procedures and call signs, dissemination of disaster data and information, and simulation of disaster scenarios (pre-disaster, disaster, and post-disaster). These simulations use shared radio frequencies assigned by DG-SDPPI, and include the use of radio communications via satellite.

Disaster radio communications framework and simulation: In accordance with the provisions of Article 20 of Law No. 36 (1999), concerning telecommunications, every telecommunications operator is obliged to give priority to the sending, distribution, and delivery of important information relating to state security, safety of human life and property, natural disasters, distress, and disease outbreaks. Law No. 24 2007, provides guidelines for disaster management. In order to support the implementation of these provisions, DG-SDPPI has prepared instructions for the management of disaster radio

²³⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0218/> from Indonesia.

²³¹ MCI: Ministry of Communication and Informatics (<https://www.komdigi.go.id/>).

²³² DG-SDPPI: Directorate General of Resources Management and Equipment of Posts and Informatics (<https://sdppi.kominfo.go.id/>).

²³³ BNPB: National Agency for Disaster Management (<https://bnpb.go.id/>).

²³⁴ Basarnas: National Search and Rescue Agency (<https://basarnas.go.id/>).

²³⁵ BMKG: Meteorological, Climatological, and Geophysical Agency (<https://www.bmkg.go.id/>).

²³⁶ BPBD: Regional Agency for Disaster Management.

²³⁷ BRIN: National Research and Innovation Agency (<https://brin.go.id/orpa>).

²³⁸ ORARI: Indonesian Amateur Radio Organization (<https://orari.or.id/>).

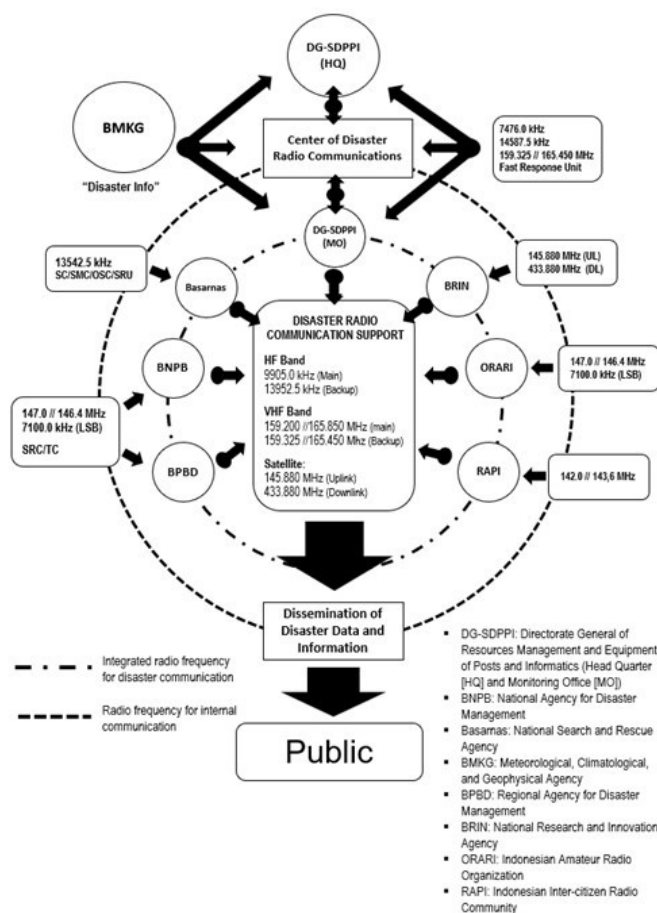
²³⁹ RAPI: Indonesian Inter-citizen Radio Community (<https://brin.go.id/orpa>).

communications, to be used as guidelines for the "radio frequency monitoring offices" that support the communication and dissemination of disaster information, in order to accelerate the recovery of telecommunication infrastructure and broadcasting capability. Disaster radio communication is employed in the pre-disaster, disaster, and post-disaster stages.

- a) **Pre-disaster stage:** Under normal conditions 'pre-disaster' involves activities to ensure the readiness of telecommunications and broadcasting infrastructure to support disaster management.
- b) **Disaster phase:** When a disaster occurs this phase comprises activities to ensure the availability of radio communications during the disaster response, including:
 - Disaster incident reports, containing information on disaster situations, the availability of radio communication and monitoring equipment, the condition of telecommunication infrastructure, and information on broadcasting affected by the disaster.
 - Collaboration with stakeholders and communities.
 - Utilizing the Centre for Disaster Radio Communication.
 - Providing disaster radio communication.
- c) **Post-disaster phase:** The recovery period this phase is carried out through activities to support the provision of radio communication networks in affected disaster areas and accelerate the recovery of telecommunications infrastructure and broadcasting capabilities.

The DG-SDPPI has developed disaster radio simulation procedures involving stakeholders and communities. These procedures include the flow of disaster communication coordination, call signs, and procedures for conveying information via available communication channels. A mapping of the roles of disaster response agencies and radio communities, etc. in disaster radio communication is shown in Figure A-48.

Figure A-48: Disaster radio communication simulation scheme



- BNPB as coordinator for national disaster
- BPBD as coordinator for regional disaster
- Basarnas as coordinator for national search and rescue
- SAR Office for search and rescue of disaster-affected victims
- ORARI, RAPI, and communities are to support radio communication equipment and its human resources
- DG-SDPPI is coordinator of the disaster radio communication centre to support disaster radio communication infrastructure, provide radio frequency allocation, and collaborate with communities

The radio frequencies used for disaster radio communications and for sharing with stakeholders and the community are as follows:

- Band HF: Main: 9 905.0 kHz; Backup: 13 952.5 kHz
- Band VHF: Main: 159.200 MHz (Tx) and 165.850 MHz (Rx); Backup: 159.325 MHz (Tx) and 165.450 MHz (Rx)

Disaster radio communication support simulations are carried out at the pre-disaster, disaster, and post-disaster phases. Persons engaging in the disaster radio communication simulation scheme are shown in Figure A-49.

Figure A-49: Disaster radio communication simulations



The role of DG-SDPPI in disaster management: DG-SDPPI comprises 35 monitoring offices spread across all provinces in Indonesia, that are equipped with radio communications and radio frequency monitoring equipment. The nearest monitoring office will engage with the disaster area to support radio communication. Other monitoring offices will provide support. Dissemination of data and information to combat hoaxes or fake news can be achieved through collaboration with stakeholder

disaster response agencies and communities. Provision of a shared frequency that can be used by the "incident commander" to coordinate with stakeholder disaster response agencies and communities results in reliable and valid information for the public. The role of DG-SDPPI in disaster management is as follows:

- Mapping the roles of stakeholder disaster response agencies and communities in disaster radio communications.
- Providing maps of telecommunication infrastructure and broadcasting as well as existing disaster radio communications, both national and regional.
- Providing technical guidance and workshops to stakeholder disaster response agencies and communities to increase competency in disaster radio communications.
- Providing radio frequency allocation for disaster radio communications that stakeholder disaster response agencies and communities can use.
- Building the Centre of Disaster Radio Communication.
- Collaboration with stakeholder disaster response agencies and communities for disaster preparedness.
- Providing radio communication and monitoring equipment belonging to the monitoring offices to be used when a disaster occurs.
- Disaster radio communication simulations and periodic radio check-ins to ensure disaster preparedness involving stakeholder disaster response agencies and communities. In addition, the radio frequencies provided for satellite communications are 145.880 MHz (uplink) and 433.880 MHz (downlink).

Conclusion: Collaboration between stakeholder disaster response agencies and communities in providing integrated disaster radio communication supports the Government of Indonesia in reducing disaster risks and increasing public awareness of disasters. Disaster radio communication simulations increase the competency of stakeholder disaster response agencies and communities in disaster management and in the use of radio communication. Using shared frequencies makes coordination more effective and efficient. In addition, reliable and valid information can be conveyed to the public without suffering the effects of hoaxes and fake news. This programme aligns with sustainable development goals (SDGs) in terms of making cities inclusive, safe, resilient, and sustainable, especially in disaster risk reduction and management.

A1.7 Other cases of disaster preparation, response, and recovery

A1.7.1 Earthquake response in Türkiye February 2023 (Türkiye)²⁴⁰

Overview of the earthquake-affected region: On 6 February 2023, two major earthquakes hit Türkiye, with the epicentres in the Pazarcık (Mw 7.7; focal depth: 8.6 km) and Elbistan (Mw 7.6; focal depth: 7 km) districts of Kahramanmaraş, at 04:17 and 13:24 local time, respectively. On 20 February 2023, another earthquake with a magnitude of Mw 6.4 occurred, with the epicentre at Yayladağı, Hatay, at 20:04 local time. These earthquakes, all of which were unprecedented in recent history in terms

²⁴⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0090/> from Türkiye.

of magnitude and coverage, caused major devastation in a total of 11 provinces. The earthquakes claimed the lives of more than 48 000 people, wreaked damage to over half a million buildings, as well as communication and energy structures, and led to significant financial losses. The total population of the 11 provinces affected by the earthquake was registered as 14 013 196 persons in 2022, accounting for 16.4 per cent of the national demographic.²⁴¹

A1.7.1.1 Communication status

The Information and Communication Technologies Authority (BTK) in Türkiye, is the regulatory authority for the electronic communication and posts sector. Operators providing services in the electronic communication sector are obliged to make business continuity plans to ensure the continuity of services, and to take necessary measures to ensure the operation of critical systems in the event of a disaster. As of the third quarter 2022²⁴², there were 464 authorized operators 840 authorizations were granted to these operators. There are 11.5 million fixed telephone subscribers and approximately 91 million mobile subscribers, with 91.4 million broadband Internet subscribers in Türkiye. The length of fibre-optic infrastructure was approximately 500 000 km. Prior to 6 February, the number of mobile subscribers in 11 provinces exceeded 15 million, while the total number of mobile subscribers in these provinces constituted approximately 16.7 per cent of the mobile subscribers in all of Türkiye. In other words, the great disaster affected one of every six mobile phone subscribers in the country. The key indicators for 2022, for the electronic communications sector in the earthquake-affected region are presented in Table A-7.²⁴³

Table A-7: Key Indicators for electronic communications sector, by Province (2022)

	Population	Number of fixed telephone access lines	Number of mobile phone subscribers	Number of fixed broadband Internet subscribers	Number of mobile broadband subscribers	Fibre-optic cable length
Adana	2 274 106	201 059	2 353 513	459 130	2 019 392	10 980
Adıyaman	635 169	50 099	658 680	78 530	597 103	3 165
Batman	634 491	42 618	455 759	64 662	422 037	2 361
Diyarbakır	1 804 880	92 667	1 515 599	192 953	1 117 182	6 764
Elazığ	591 497	72 125	535 605	96 409	449 384	4 818
Gaziantep	2 154 051	161 904	1 941 159	387 578	1 693 922	8 128
Hatay	1 686 043	148 862	1 529 763	294 313	1 333 527	6 078
Kahramanmaraş	1 177 436	105 904	1 004 781	180 849	872 654	6 729
Kilis	147 919	13 308	169 317	25 617	143 953	1 114
Malatya	812 580	100 650	715 683	143 209	631 164	5 676
Mardin	870 374	53 645	619 924	97 017	568 454	4 113
Mersin (içel)	1 916 432	182 243	1 639 320	428 456	1 349 009	9 849

²⁴¹ <https://www.sbb.gov.tr/wp-content/uploads/2023/03/2023-Kahramanmaraş-and-Hatay-Earthquakes-Report.pdf>.

²⁴² <https://www.btk.gov.tr/uploads/pages/pazar-verileri/2022-3-k-disi-3ocak-63f71da4999a3.pdf>

²⁴³ <https://www.btk.gov.tr/uploads/pages/yillik-il-istatistikleri/2023.pdf>

Table A-7: Key Indicators for electronic communications sector, by Province (2022) (continued)

	Population	Number of fixed telephone access lines	Number of mobile phone subscribers	Number of fixed broadband Internet subscribers	Number of mobile broadband subscribers	Fibre-optic cable length
Osmaniye	559 405	47 026	458 436	85 382	419 502	2 874
Şanlıurfa	2 170 110	95 291	1 520 795	159 234	1 415 637	6 268
Regional Total	17 434 493	1 367 401	15 118 334	2 693 339	13 032 920	78 917
Türkiye	85 279 553	11 197 928	90 297 565	18 998 803	71 651 056	517 325

The physical collapse of buildings and the heavy damage to some of the base stations on the buildings affected mobile communication in the region. In mobile services there was no loss of service in the core network, and there was no problem at the interconnection points. The main problems in communication were due to the power outages, difficulties in fuel supply, and the bad weather conditions.

A1.7.1.2 Post-earthquake actions

After the earthquake, under the coordination of the Disaster and Emergency Management Agency (AFAD), a Disaster Emergency Relief Coordination Group consisting of government ministries, relevant institutions and stakeholders carried out their duties. The Türkiye Disaster Response Plan (TAMP) was prepared in 2014, to ensure effective response to disasters in line with the experiences gained from previous disasters. The TAMP ensured identification of the roles and responsibilities of the working groups and coordination units, and determined the basic principles of response planning before, during, and after disasters. The TAMP includes government ministries, institutions, and organizations, as well as the private sector, non-governmental organizations, and the people, that would take part in responding to potential disasters and emergencies of all types and scales that could occur in Türkiye. The "Communications Disaster Group"²⁴⁴ which includes the Ministry of Transport and Infrastructure, BTK, and the operators, came together within the framework of the TAMP and started to work from the first moment the earthquake occurred. Operators were instructed to deliver all trailer mobile base stations to the disaster area. 40 trailer-type mobile base stations and 500 mobile base stations, and emergency communication vehicles, and nearly 2 200 personnel were dispatched to the region. VSAT satellite terminals and Wi-Fi access points were installed in the earthquake area. As one of the main problems in communication was due to the power outages and difficulties in fuel supply, 3 500 generators were sent to the region. Wireless access points were provided for Internet needs in the temporary settlement areas. One of the main tasks of BTK is to protect consumer rights and interests. In this context, to give an immediate response, a regulatory decision was taken after the earthquake by the BTK Board on 14 February 2023.²⁴⁵ The Board decision advised operators to provide various facilities to consumers affected by the earthquake, such as:

- Providing free services and benefits to subscribers for a minimum of one month.
- Postponing the payment date of bills for at least one month.
- No fees for SIM changes or changes of service address, no charge for early terminations of committed term contracts, etc.

²⁴⁴ https://www.afad.gov.tr/kurumlar/afad.gov.tr/e_Kutuphane/Planlar/TAMP.pdf

²⁴⁵ <https://www.btk.gov.tr/uploads/boarddecisions/deprem-felaketi-sebebiyle-alinacak-tedbirler/66-2023-web.pdf>

- Clearing of bills and waiving of receivables related to communication services for the subscribers who lost their lives in the earthquake.
- For subscribers who cannot reach their identity documents, operators will use alternative methods for verifying their identity for SIM changes and SIM card requests.

Implementation dates of some newly enacted regulations were also postponed by 2-4 months to encourage the operators to focus on the measures they needed take due to the earthquake. Apart from all above, to contribute to the normalization and relief effort in the region, A BTK Academy mobile technology truck arrived in the region and provided training for children on various subjects such as coding and robotics. Approximately 150 children per day received training in the mobile classrooms of BTK Academy.

A1.7.1.3 Recovery period, business continuity and risk assessment

Following the earthquake, operators were instructed to review their business continuity plans and the resources for use in emergency situations. Special attention was drawn to the following issues and requirements:

- To increase redundancy and fibre-optic connections to the base stations especially for radio link connected sites.
- To increase resources such as mobile base stations, generators, and batteries to be used in the emergency.
- To use national roaming in case of emergencies.
- To update the risk analysis for critical infrastructure based on the geographical data sets and maps and relocate the base stations that are in the high-risk areas.
- To review supply plans in collaboration with local energy supply companies and take necessary measures to provide continuous energy for communication infrastructure and systems in the event of disasters.

In addition, the national risk shield model of Türkiye is currently being developed with the participation of all stakeholders.

A1.7.2 Building resilient infrastructure in Japan - Early recovery response to the Noto Peninsula Earthquake (Japan)²⁴⁶

Strengthening measures in preparation for large-scale disasters: Given the importance of mobile communications, and especially of mobile phones, which often serve a lifeline during disaster events, it is extremely important to strengthen the disaster resistance of communications infrastructure. In Japan, and particularly since the Great East Japan Earthquake of 2011, mobile phone carriers have been working to strengthen measures against transmission line interruptions, power outages, and equipment failures. *1 Additionally, the Ministry of Internal Affairs and Communications (MIC) has amended relevant ministerial ordinances requiring businesses to strengthen countermeasures, *2 deployed mobile power supply vehicles, and created a response team (MIC-TEAM) that provides disaster response support to secure means of information and communication in the event of a disaster. MIC also made it mandatory for mobile phone base stations that cover important locations, such as municipal offices, to take measures against power outages for at least 24 hours *3 to ensure

²⁴⁶ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0220/> from Japan.

communication during disasters. In addition, since it is important to secure a means of communication so that administrative agencies can operate smoothly even when communication services, such as mobile phones, have stopped, MIC has established a satellite mobile phone network. By stockpiling rental radio equipment and deploying it in each region, MIC have established a system that will enable efficient lending of satellite mobile phones, etc. to local government authorities. Furthermore, in order to secure electricity and fuel, MIC cooperates with related ministries and agencies, through liaison systems and by conducting joint training exercises. Telecommunications carriers, the Ministry of Defence, and the Self-Defence Forces have concluded agreements regarding mutual cooperation in securing communications during disasters, including the implementation of training exercises, the sharing of information important for recovery activities during disasters, and the provision of recovery materials and supplies. Efforts are being made to strengthen cooperation regarding the transportation of disaster recovery personnel.

- *1 Mobile phone carriers have installed over 800 satellite entrance lines that connect mobile base stations via satellite. As of March 2023, the four mobile carriers have over 4 300 mobile power supply vehicles and portable generators, and 24-hour backup power, to cover problems with terrestrial lines, as well as over 11 400 time-based base stations.
- *2 The Business Telecommunications Equipment Regulations (Ministerial Ordinance) were revised in 2012. The revised regulations include provisions for strengthening the disaster resistance of transmission line equipment, strengthening power outage countermeasures, and strengthening large-scale disaster countermeasures.
- *3 In response to the widespread and long-term outage of mobile base stations in the Kanto region due to the power outages caused by a typhoon in 2019, the information and communication network safety and reliability standards (notifications) were revised in 2020. The revised standards require 24-hour backup power for mobile phone base stations that cover municipal offices and recommend 72-hour backup power for prefectural offices, remote islands, and other offices that are difficult to reach.

Early recovery response to the Noto Peninsula Earthquake. In response to the Noto Peninsula Earthquake in January 2024, MIC collaborated with telecommunications carriers to immediately collect damage information, and dispatched the MIC-TEAM to quickly restore telecommunications services to Ishikawa Prefecture. For mobile services, the service coverage area in six cities and towns in the northern part of the Noto Peninsula had decreased to less than a third of the pre-disaster service coverage area, due to commercial power outages, equipment failures, collapse or damage to base stations, and disconnection of transmission lines. Problems occurred in 70 to 80 per cent of areas. To restore mobile phone services quickly, telecommunications carriers installed emergency recovery equipment, such as mobile power supply vehicles and portable base stations.

- *4 As a result of mutually coordinated efforts, which included coordinating with related organizations for the transportation of fuel and personnel, and in the of clearing roads, the emergency restoration work was largely completed by mid-January, just two weeks after the earthquake.
- *5 for transporting fuel and personnel and clearing roads, emergency restoration work was largely completed in mid-January, except for difficult-to-access areas.

In addition, to ensure a communication environment at evacuation centres and other locations, mobile phone carriers lent approximately 660 satellite Internet devices (Starlink terminals) free of charge and provided mobile terminals, etc. MIC also provided mobile power supply vehicles and mobile terminals. MIC had been working on collaborative efforts, such as the renting out of communication equipment

such as satellite mobile phones. While major roads were cut off by landslides and restoration work was difficult, the preparations and countermeasures that had been undertaken by the public and private sectors were put to good use.

- *6 A maximum of approximately 330 power supply vehicles and generators are available for both the public and private sectors. Additionally, each carrier operates up to approximately 100 in-vehicle/portable base stations.
- *7 Some examples are that the Japan Maritime Self-Defense Force provided transport ships to refuel and transport recovery equipment to difficult-to-reach areas, and the Ministry of Land, Infrastructure, Transport and Tourism made road clearance necessary for base station restoration work.

Prospects for securing communications in the event of future disasters. During this disaster response phase, efforts were made by mobilizing all possible means, including emitting radio waves from coastal areas using ship-based base stations and covering the area with temporary base stations using drone technology. In addition, satellite internet equipment (Starlink terminals) was widely used as a replacement when the optical fiber to mobile base stations was cut off, and to secure a means of communication at evacuation centers. The MIC conducted the necessary verification of the causes of the disaster and its response and took into account the progress made in efforts to utilize new technologies, such as satellites and drones, as well as the progress made in public-private collaboration. Efforts will be made to further strengthen the communication environment so that communication will not be disrupted from time to time. In addition, Japan will introduce "inter-operator roaming" by the end of fiscal 2025, which allows mobile phone users to temporarily use another carrier network in the event of an emergency.

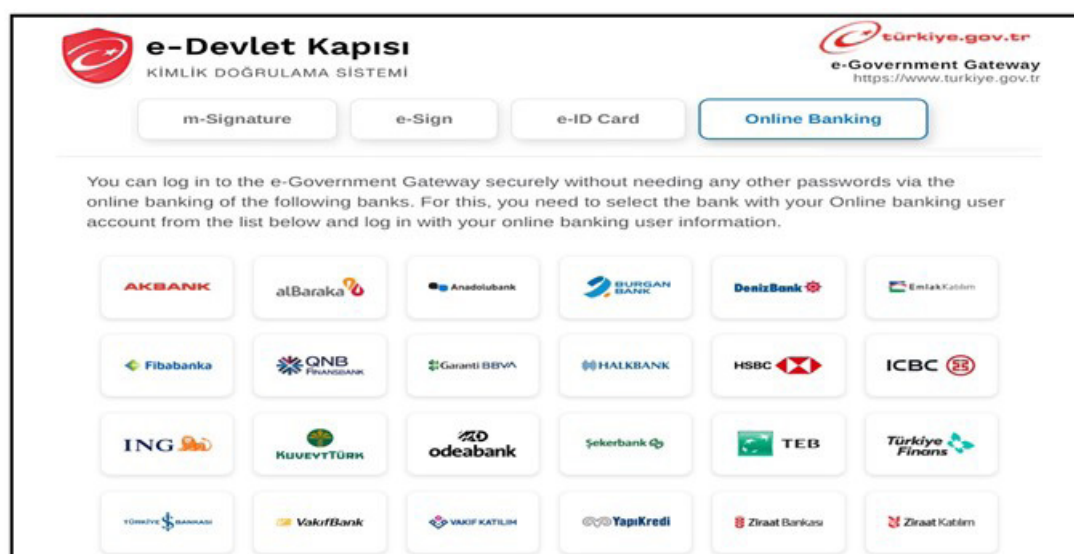
A1.7.3 Electronic contract termination service through the e-Government gateway (Türkiye)²⁴⁷

Necessity for an electronic contract termination service: Consumers receiving services from operators in Türkiye were only able to apply for termination of their subscription contracts in written form in accordance with the legal regulations in the electronic communications sector. In order to facilitate the termination of contracts by consumers, the Law on Electronic Communications was amended in 2020 to remove the written form requirement.

Implementation of the Regulation. With the aforementioned regulation, secure login methods, as shown in Figure A-50, have been developed in order to ensure that applications for termination of subscription contracts can be made safely through eDK.

²⁴⁷ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0345/> from Türkiye.

Figure A-50: Image of eDK



The electronic contract termination service has been welcomed by consumers and especially by disadvantaged groups (such as the elderly, persons with disabilities, etc.) and those living in rural areas, as it ensures the protection of consumers in situations where physical contact is difficult, such as during epidemics. It also allows subscription contracts to be easily terminated without the need to go to operators' dealerships or shops. The electronic contract termination service received an award in the e-Government category at the World Summit on the Information Society 2022, (WSIS Prizes)²⁴⁸.

A1.7.4 Integration of drones across the four key phases of DRM - mitigation, preparedness, response, and recovery (Rwanda)²⁴⁹

Rwanda, is vulnerable to various natural disasters, including floods, landslides, earthquakes, and droughts. With the increasing frequency of these disasters due to climate change, there is a growing need to integrate technology in disaster risk management (DRM). The United Nations Office for Disaster Risk Reduction (UNDRR) highlights the importance of adopting technologies to enhance disaster preparedness, reduce risks, and ensure effective response and recovery (UNDRR, 2020). This focuses on the role of drones in the four key phases of DRM: mitigation, preparedness, response, and recovery, and provides a detailed analysis of their application in the context of Rwanda.

Disaster risk management (DRM) phases. Disaster risk management consists of four phases: mitigation, preparedness, response, and recovery. Each phase is crucial in minimizing the impact of disasters on human lives, infrastructure, and the environment.

²⁴⁸ <https://www.itu.int/net4/wsis/stocktaking/Prizes/2024/Details/16427478805122477>

²⁴⁹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0434/> from Rwanda.

Figure A-51: Four phases of disaster risk management



Source: ITU 2020

Mitigation: Mitigation refers to efforts to reduce the potential impact of disasters before they occur. Mitigation involves the implementation of long-term measures aimed at reducing risks posed by natural hazards. Drones can play a critical role in this phase by conducting aerial surveys to identify areas prone to flooding, landslides, or other hazards. These surveys provide accurate data for mapping and monitoring risk-prone areas in Rwanda, which can help in planning infrastructure development and enforcing land-use regulations. For instance, drones equipped with geographic information systems (GIS) technology can produce detailed maps of flood-prone areas along the Nyabarongo River, which is essential for designing effective flood mitigation strategies (Johansen et al., 2019).

Preparedness: Preparedness focuses on equipping individuals, communities, and governments with the tools and knowledge necessary to manage potential disasters. In this phase, drones can be used to simulate disaster scenarios and assess vulnerabilities. Their ability to capture real-time data enables the generation of risk models, which can be used to design EWSs. Drones can also be employed to inspect critical infrastructure such as dams and bridges in Rwanda, ensuring they are resilient to potential hazards. Rwanda's National Risk Atlas already highlights vulnerable regions, and integrating drone technology into national preparedness strategies could enhance these assessments (National Risk Atlas of Rwanda published by the ministry in 2015).

Response: The response phase deals with immediate actions taken during or after a disaster to save lives and minimize damage. In disaster-stricken areas, drones can be deployed to assess the situation and provide real-time images of affected zones. This allows rescue teams to prioritize resources and deploy personnel more effectively. Drones can also deliver medical supplies, food, and water to hard-to-reach areas, as demonstrated during the flood crisis in 2018, in the Western Province of Rwanda, where roads were inaccessible (Moore et al., 2021). In Rwanda, drones could be especially valuable in mountainous regions, where traditional access can be challenging.

Recovery: Recovery involves rebuilding affected communities and restoring normalcy after a disaster. In this phase, drones can be used to monitor the progress of reconstruction efforts and ensure that rebuilding projects comply with safety and sustainability standards. Aerial surveys conducted by drones can also help identify areas where rehabilitation efforts are still needed. In the aftermath of the 2020 floods in Musanze District, for example, drones could have facilitated a quicker assessment of damaged infrastructure, expediting the recovery process (Johnson et al., 2021).

The role of drones in disaster management in Rwanda: The Vision 2050 plan outlines the importance of integrating modern technologies into national development efforts, including disaster management. The Government of Rwanda has already shown a commitment to using drones in various sectors, such as healthcare (e.g., delivering blood supplies via Zipline drones). Expanding the use of drones in disaster management is a logical next step. The National Disaster Management Policy (NDMP) of

Rwanda highlights the need for EWSs, risk assessment, and efficient response strategies, all of which can be enhanced through drone technology (NDMP, 2018).

Cost-effective and accessibility: One of the key advantages of drones is their cost-effectiveness compared to traditional methods of monitoring and assessment. For example, conducting a manned aerial survey over a flood-prone area is significantly more expensive and time-consuming than deploying a drone. Drones can quickly gather data from remote areas that would otherwise be difficult or dangerous to access, particularly in regions like the Northern Province, which is prone to landslides.

Environmental monitoring and EWSs: Drones equipped with sensors and cameras can be used to monitor environmental changes and provide early warnings of potential disasters. For instance, a drone monitoring river levels in flood-prone areas could alert authorities to rising water levels, triggering evacuation plans. This technology can also be used to monitor landslide-prone areas such as the slopes of the Virunga Mountains, providing crucial data that can inform mitigation measures.

Challenges and opportunities: While drones present numerous benefits, there are also challenges to their widespread adoption in the disaster management efforts of Rwanda. Regulatory frameworks governing the use of drones need to be strengthened to ensure safe and effective deployment during disasters. Additionally, there is a need for financial investment and capacity building in terms of training of personnel to operate drones and interpret the data they collect. On the other hand, the opportunities are immense. Rwanda's investment in ICT infrastructure provides a strong foundation for the integration of drones into DRM. By collaborating with international organizations and the private sector, Rwanda can continue to enhance its disaster management capabilities using drones.

Conclusion: In conclusion, the use of drones in disaster risk management in Rwanda can significantly improve the ability of the country to mitigate, prepare for, respond to, and recover from disasters. As climate change continues to exacerbate the frequency and intensity of natural disasters, it is imperative that Rwanda continues to invest in technology-driven solutions such as drones to enhance its disaster management efforts. By addressing the regulatory and operational challenges, Rwanda can lead the way in using drones for effective DRM, protecting lives and ensuring sustainable development. By utilizing advanced technologies such as AI, ICT, and data analytics, drones can become invaluable tools in improving situational awareness and decision-making processes during disasters. The choice between establishing an in-house drone fleet, and leveraging drone-as-a-service models depends on various factors, including cost, control, and operational needs. Regardless of the approach, the strategic deployment of drones will play a crucial role in building a resilient disaster management framework in Rwanda, ultimately contributing to the safety and well-being of its citizens.

References

- Johansen, K., Tiede, D., & Blaschke, T. (2019). Drones for urban and environmental monitoring. *Journal of Geographic Information Science*, 12(3), 123-145.
- Moore, J., et al. (2021). Disaster response and UAVs: A case study in East Africa. *Disaster Management and Prevention*, 22(4), 231-245.
- Rwanda Ministry of Disaster Management and Refugee Affairs. (2015). *National Risk Atlas*. Kigali: Government of Rwanda.
- Johnson, L., et al. (2021). Post-disaster recovery and infrastructure: The role of drones in Rwanda's flood response. *Urban Disaster Studies*, 9(2), 98-109.
- National Disaster Management Policy (NDMP). (2018). Kigali: Government of Rwanda.
- United Nations Office for Disaster Risk Reduction (UNDRR). (2020). *The Role of Technology in Disaster Management*. Geneva: UNDRR.

A1.7.5 The ETC return on investment (ROI) model: Informing risk-resilient telecommunications infrastructural development (WFP-ETC)²⁵⁰

Introduction and background: Successful disaster management relies on resilient infrastructure, including resilient telecommunications infrastructure. In 2021-22, the Emergency Telecommunications Cluster (ETC), led by the World Food Programme (WFP), developed a rate of return on investment (ROI) model for assessing the benefits of investment in emergency telecommunication preparedness, with the aim of generating empirical evidence of cost effectiveness, and ultimately of encouraging humanitarian-development stakeholders to build more disaster-resilient telecommunications. This model quantifies and qualifies the benefits of investments in emergency telecommunications preparedness, particularly in terms of:

- Providing decision-makers with insights that make a case for greater and more sustained investments in disaster-resilient emergency telecommunications which, in turn, can further reduce devastating impacts of disasters.
- Improving the qualitative and quantitative analyses that support pre- and post-disaster assessments of telecommunications infrastructure.
- Encouraging resilient, redundant, and interoperable communications in support of disaster response and recovery efforts.

Challenges the ROI model addresses: As disasters become more frequent and severe, a growing number of telecommunications, regulatory, and disaster management authorities have expressed a keen interest in enhancing preparedness and communications network resilience. However, the desire alone to enhance national telecommunications preparedness and ICT network resilience is not in itself sufficient. Investment-benefit numbers drive decision-making, informing national budgeting and planning efforts. These insights gave rise to development by the ETC of this first-of-its-kind ROI model to quantify and qualify emergency telecommunications preparedness and investment efficacy, which is reflected in an investment-benefit ratio. Since this model was first presented at the ITU-D Question 3/1 workshop in spring 2023, it has been applied to three country contexts by the WFP-led ETC in Mozambique (2021-22), Madagascar (2022-23), and Dominican Rep. (2023-2024). This contribution will discuss the following high-level findings and recommendations, with reference to application of this model:

Problem statement and ROI model considerations: This evidence-based model seeks to inform the decision-making of donors, government, and other humanitarian actors, by identifying priority pre-emptive emergency telecommunication investments. The results of the model will indicate whether sustained investment in enhanced stakeholder coordination, national-level capacitation, and infrastructural readiness could improve the efficiency of disaster response, and what forms such investment could take. The ROI model is designed to be used by all development-humanitarian partners engaged in emergency telecommunications preparedness, including WFP. It is based on the practical emergency preparedness expertise and experiences of the ETC in different countries. All humanitarian partners involved in emergency preparedness, particularly within the emergency telecommunications sector, can readily apply the model using their own data. The model consists of two dimensions, the qualitative and quantitative, whose constituents are shown in Figure A-52 below.

²⁵⁰ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0202/> from World Food Programme-led Emergency Telecommunications Cluster (WFP-ETC).

Figure A-52: Qualitative and quantitative components of the ROI model



Underlying assumptions in the quantitative and qualitative application of the ROI model include:

- The quantitative ROI model focuses only on investments and benefits that are quantifiable from an economic standpoint. All other benefits stemming from investments in emergency telecommunications preparedness are evaluated using a qualitative approach.
- The model only considers risks related to three types of rapid onset high-impact disasters (cyclones, earthquakes, and floods).
- The model also reflects a discount rate to reflect the depreciation of infrastructural assets over time, that is consonant with the life-cycle of physical infrastructure.
- When evaluating the risk of a particular scenario occurring (while creating the country risk profile component), the assumption is that each disaster event (be it cyclone, flood, or earthquake) is independent of the others, with the Emergency Events Database (EM-DAT) as the principal data source.
- Different global warming scenarios alter the likelihood of an event occurring considerably, introducing a high degree of volatility in the overall model. Therefore future-facing climate data is not directly factored into the model.

Brief ROI application case in Mozambique, Madagascar, and Dominican Rep.: The ROI model was launched by the ETC after a nearly a year-long development process, devised in collaboration with Deloitte Italy. The approach was initially shared with Cluster partners for feedback and validation and ultimately was published online in early 2022. Based on advocacy efforts by the ETC, complemented by country interest post-disaster, the model was initially applied in Mozambique as a pilot following Cyclones Kenneth and Idai, then applied subsequently in Madagascar post-Cyclone Batsirai, and most recently in Dominican Rep. following Hurricane Fiona. The application of the ROI model following emergency communications responses sought to demonstrate the efficacy of preparedness investments in the aftermath of a disaster. WFP country offices, in collaboration with the ETC team collaborated to collect the data. Data-entry was undertaken by the ETC in two cases, and by a WFP Country Office in one case. National government focal points from the ICT authority and/or disaster management agency were involved, to ascertain more granular insights, both quantitatively and qualitatively. The investment-benefit data drew principally on WFP and ETC investments made in emergency preparedness, and the benefits were derived based on an avoidance cost premise. The flexibility of the model in terms of reflecting context-specificities enabled data entry for these three

country contexts without modifying the core structure of the model. A snapshot of the results for the three application cases is available at Annex 3 of the full ROI study, and is available at <https://www.etcluster.org/document/return-investment-roi-model>. As per Annex 3, the final ROI numbers range from 2.96 to 2.47, reflecting that for all three country cases, for every 1 USD invested in emergency telecommunications preparedness, the returns in terms of quantifiable savings in times of disaster response are more than double. For Madagascar and Mozambique, the ROI is just under triple. These results were presented in each country to the national emergency telecommunications preparedness stakeholders and WFP country teams to inform decision-making, as well as for identifying planning and budgeting opportunities. Briefings were also conducted for the ETC Cluster partners who engage in coordination and provision of communications in emergencies, and the model was shared at different humanitarian-development forums including the Humanitarian Networks and Partnerships Weeks 2022.

Good practices and lessons learned in ROI application. In each country where the ROI model has been applied, it has proven, in quantifiable terms, that investing in emergency communications preparedness capacity development and coordination pays off ahead of a disaster, with an ROI at least double that of the initial investments made in emergency preparedness.

- ROI model results can be used to advocate for increased preparedness and resilience awareness. The results can then be leveraged to encourage donor finance for emergency communications preparedness efforts. One application country cited the ROI in a successful proposal for increased emergency preparedness in capacity building and infrastructure enhancement terms.
- In one case, a government used the ROI findings to report against progress on UN parameters covering resilience and disaster readiness, when reporting to the Sendai Framework.
- Investments in more resilient communications infrastructure must consider capacity and maintenance efforts that enable communications networks to remain functional over time and during disasters or other disruptions. This includes maintenance schedules and regular inspections, testing and refurbishment of communications network equipment.
- Ensuring redundant back-up power capabilities is crucial for maintaining and restoring communications in emergencies.
- Multi-hazard risk profiling is a crucial layer informing the overall ROI analysis that contextualizes the investment-benefits information in a multi-risk context.
- Knowing the "spread of investments", or simply the investments made by category across coordination, capacity development and infrastructure, helps in strategizing national planning and budgeting decisions. Understanding how these investments are distributed has helped both national partners and the ETC to consider supporting, or enabling, specific operational and capacity development support activities in-country.
- The highest returns on investments do not always lie in the sector that receives the highest investment. In all three country cases, though investments in infrastructure were among the highest expenditures, the financial returns for increased coordination and capacity development terms were highest (refer to Annex 3).
- Infrastructure-focused solutions alone are insufficient. Equally important are investments in people. Augmenting infrastructure should ideally be accompanied by investments to

increase coordination and capacity development, for example setting up a national ICT emergency coordination mechanism, simulations to test existing standard operating procedures, and targeted trainings to meet national ICT needs.

- Partnerships, communications, and resource mobilisation efforts leveraging ROI findings need to be undertaken simultaneously to be able to truly create opportunities for increasing emergency telecommunications investments.

Next steps and opportunities: Following the successful application of the ROI model in three countries, the key next steps are listed as follows:

- National governments and humanitarian partners are encouraged to contact the ETC for information on the ROI model, and how they might apply it to determine their ROI in emergency telecommunications on their own initiative, with the ETC providing technical/ advisory support.
- Applying the model in regional contexts is a point of interest being explored, and if it is feasible to create an aggregated ROI based on multi-country data.
- Trickle-down effects of national to local telecommunications resilience is a challenge and needs particular attention when national investment plans and budgeting activities are undertaken for augmenting coordination, capacity development, and improving infrastructural provisions. In this respect, ensuring investment efforts are distributed to local levels is crucial to build resilience at every level.
- The ETC is currently developing a social rate of return-on-investment model, which will examine the community resilience benefits of investment in emergency telecommunications preparedness.

A1.7.6 BDT report on the emergency telecommunications work including activities, events, and resources^{251, 252, 253, 254, 255}

Disaster preparedness

ITU support to the United Nations initiative on 'Early Warning Systems for all': ITU is supporting the United Nations initiative on 'Early Warning Systems for all'. This climate change adaptation measure, announced by the United Nations Secretary-General in March 2022, stipulates that by 2027 every person in the world should be protected by an EWS. To achieve this goal, ITU will highlight the opportunities brought by the growth in digital services to effectively reach and deliver alerts to people at risk; especially over mobile cellular networks, which reach a very large percentage of the population. ITU will work closely with WMO, and other partners, in supporting the United Nations Global Early Warning Initiative by engaging mobile network operators and regulators, as well as identifying and sharing best practices and expertise. WMO, which has been designated to lead on this initiative, presented an 'action plan' on the initiative during COP27, in Egypt in November 2022. On 22 October 2022, ITU presented on the Technical Conference "The UN Global Early Warning Initiative

²⁵¹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0030/> from BDT.

²⁵² ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0062/> from BDT.

²⁵³ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0169/> from BDT.

²⁵⁴ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0158/> from BDT.

²⁵⁵ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0317/> from BDT.

For Climate Adaptation: Early Warnings For All", organized by WMO, to highlight the importance of ICTs, and in particular mobile network and services, in developing effective EWSs. The purpose of the conference is to explore the global EWS value cycle and to develop strategic partnerships in support of a coordinated action plan for this initiative. On 14 Feb 2023, the ITU Regional Office for Africa presented at the WMO Regional Conference on digital technologies on mobile EWSs and the United Nations Early Warnings for All initiative. The presentation highlighted the opportunity to reach more people at risk, presented by the increasing coverage of mobile network and services, shared best practices in Europe on the regulatory approach, and the ITU roles in the overall initiative. ITU participated in a panel session on 'Disaster Risk Reduction and Climate Change: Sustainable Early Warning – Early Action' during the second edition of the European Humanitarian Forum, which took place on 10 March 2023. The session brought together a panel of humanitarian actors and academic experts and discussed opportunities for building efficient multi-hazard EWSs. ITU highlighted the UN Early Warning for All initiative and the opportunities that a growing digital world has for reaching communities at risk. On 21 April 2023, ITU presented the Early Warning for All initiative (EW4All), and the mobile EWSs in the EENA Conference & Exhibition, organized by the European Emergency Number Association (EENA). This event brought together professionals across the public safety field including governments, emergency services, researchers, solution providers, and mobile network operators. ITU BDT is working closely with EENA in the context of the UN Early Warning for All initiative (EW4All), where ITU is leading on the 'Warning Dissemination, and Communication' pillar, to promote mobile EWSs (CB and location-based SMS) as critical technologies to reach people at risk.

During May to October 2023, ITU was actively engaged in the EW4All workshops and events. ITU presented the ITU-led pillar 3 on warning dissemination and communication, including high-level events aimed at raising awareness of EWS, driving the initiative forward, and gaining momentum. These events included the WMO Congress in May 2023, workshops, and the launch of the Africa EW4All initiative, as well as the University College London Warning Research Centre 'Creating Effective Warnings For All' conference. ITU was also represented at the Climate Ambition Summit in September 2023, and the EW4All advisory meeting in October 2023. As part of its work to support the EW4All warning dissemination and communication pillar, ITU released a detailed background paper on "Digital Transformation and EWSs for Saving Lives" in October 2023, to point to the opportunities offered by the growing availability and reach of mobile networks and services to alert communities at risk. The paper also delves into the legislative approach adopted by 33 countries to speed up the implementation of mobile EWS. ITU participated in the Water at the Heart (which is coordinating closely with the EW4All initiative) workshop in Uganda, to present the pillar 3 discussions and activities with key stakeholders in the country, from 15-17 November 2023. ITU participated in the Barbados National Consultative Workshop on Early Warning Systems (EW4ALL) convened on 1 and 2 November 2023, by the United Nations EW4ALL Pillar leaders (UNDRR, WMO, ITU, IFRC), in collaboration with the Department of Emergency Management (DEM) of Barbados. ITU presented the pillar 3 discussions and activities with key stakeholders in the country. ITU participated in the Antigua and Barbuda National Consultative Workshop on Early Warning Systems (EW4ALL) convened on 12 December 2023, by the United Nations EW4ALL Pillar leaders (UNDRR, WMO, ITU, IFRC) in collaboration with the National Office of Disaster Services of Antigua and Barbuda. ITU presented the pillar 3 discussions and activities with key stakeholders in the country.

ITU, together with IFRC, released a video on mobile EWS for saving lives in December 2023, to feature the use cases of CB and highlight the potential of reaching populations at risk through mobile networks. During COP-28, on 1 December, ITU, together with WMO, UNDRR and IFRC, organized a session featuring the potential of AI to accelerate processes and address gaps to achieve the Early Warnings for All initiative. The session 'Early Warnings for All: Artificial Intelligence to unlock the potential of Early Warning Systems', presented recent relevant best practices in the application 'Artificial Intelligence to make early warnings more accessible, efficient, and actionable'. Also during COP-28, commitments and pledges from the mobile and satellite community to support multi-channel alert dissemination under EW4All were featured in a side event on 4 December 2023 titled 'Digital connectivity and technologies for the Early Warning for All initiative'. This side-event was part of the ITU-led Green Digital Action track. ITU participated the EW4All kick-off workshop in Fiji on from 29

February to 1 March 2024, to present the approach on warning dissemination and communication and lead the gap analysis to identify gaps and priorities. There were National Launch & Consultation Workshops on Early Warnings for All (EW4All) initiative, in countries such as Comoros (15-19 April 2024), Republic of Djibouti (7-8 May 2024), Ecuador (2-3 July 2024), Republic of Liberia (22-23 July 2024), and Republic of Seychelles (30-31 July 2024).

ITU is spearheading the development of an AI-powered advanced visualization tool that will improve the assessment of subnational connectivity levels during and after disasters, facilitating more effective communication in high-risk areas. Launched in 2020, with the United Nations Emergency Telecommunications Cluster and GSMA, the Disaster Connectivity Map has been activated over 50 times in more than 30 countries, aiding first responders, United Nations agencies and governments by providing near real-time information on communication network status. The tool developed in partnership with Microsoft AI for Good Lab, IHME at the University of Washington, and Planet utilizes AI to rapidly analyse satellite imagery and generate high-resolution, time-enabled population density maps. It also processes and visualizes connectivity data, offering both historical baselines and real-time performance maps. The tool plays a key role supporting EW4All by identifying gaps in telecommunication coverage and assessing which messaging channels (fixed broadband, 2G SMS, 3G+, etc.) are available for disseminating early warning notifications. By quantifying the offline population, meaning those unable to receive emergency alerts due to lack of network coverage, the tool helps determine the reach and effectiveness of EWSs before and after disasters. Initial piloting is underway in Fiji, Tonga and Vanuatu, with plans to expand to additional countries involved in EW4All to enhance disaster response and connectivity resilience globally. A sub-working group on AI for EW4All has been formed to specifically show how AI can support the attainment of the EW4All Initiative objectives. The key partners and organizations of the AI sub-group are: UNDRR, ITU, WMO, IFRC, UNDP, UNFCCC, ITU/WMO/UNEP Focus Group on AI for Natural Disaster Management, Google, Microsoft, GSMA, and Group on Earth Observations (GEO). A workshop on 'Forecasting the future: AI in early warning systems' (attended by 160 people) was organized on 31 May 2024, as part of the ITU AI for Good Global Summit, to foster dialogue and collaboration among stakeholders including donors, present gaps for the achievement of EW4All, encourage new partners to join, and make commitments to innovative AI solutions that could contribute to the advancement of the initiative. ITU participated in a virtual side event of the G20 DRR Working Group in support of the Brazilian Presidency, focusing on the use of bell broadcast (CB) under the context of Early Warnings for All, on 8 May 2024. ITU Asia and the Pacific Regional Office organized a Masterclass on inclusive and resilient Broadcasting development on 1 and 2 September 2024. The event was organized as a pre-event during 19th Asia Media Summit (AMS) 2024, which was organized by the Asia-Pacific Institute for Broadcasting Development (AIBD) in Kuala Lumpur, Malaysia. The event highlighted the role of broadcasting as an indispensable component of EWSs while focussing on the strengths of traditional and modern broadcasting technologies which can enhance community preparedness and response in saving lives and in reducing the impact of disasters. The event was supported by the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) of Australia. ITU provided technical assistance and advice to both Georgia and Moldova on mobile EWSs.

In collaboration with other pillar leads, ITU BDT is working on the technical implementation of EW4All, including the design of implementation plans, roadmaps, development of the toolkits, and coordination of the initiative. ITU is also collaborating with various stakeholders, including regulatory authorities, the committee for radio and TV, GSMA, mobile network operators, satellite industries, big tech companies, and community actors, to design and roll out the EW4All country programmes. This effort includes country workshops such as the Tajikistan EW4All launch workshop. Additionally, ITU BDT is working to develop guidelines on mobile EWSs to support countries in adopting CB and/or location-based SMS, including, regulatory information and guidance, as well as technical specifications to support the bidding process. ITU BDT also continues to raise funds for the initiative, with the support of ITU Member States and ITU-D Sector members, and in close coordination with its EW4All partners WMO, UNDRR, and IFRC.

National Emergency Telecommunication Plans (NETPs): ITU BDT continues to support countries in the development of their National Emergency Telecommunication Plans. Currently these countries are: Afghanistan, Solomon Islands, Ecuador, Fiji, Malawi, Kiribati, Tonga, Mongolia, Federation of Saint Kitts and Nevis, and Peru. Countries that have requested assistance include Nepal, Republic of Paraguay, Republic of Iraq, and State of Palestine. To further support countries in developing NETPs, ITU undertook baseline assessments to identify the availability of national laws, regulations, and policies governing emergency telecommunications within the Arab and Americas Member States, and the Pacific Islands. The assessments help to track ITU Strategic Goals and in particular the Target 3.5, and shows that 29 per cent of countries assessed have an NETP. ITU BDT is supporting Zimbabwe, United Republic of Tanzania, and Republic of Namibia with the implementation of a tailored NETP. Furthermore, ITU started to support the African Anglophone countries with a similar NETP model that will benefit them. In the same line, ITU is finalizing the NETP for Saint Vincent and the Grenadines, as well as for Georgia, which has a special focus on the implementation of CB. In 2023, following the request from Southern African Development Community (SADC), EET developed an emergency telecommunication assessment of, and prepared a SADC model NETP for, the SADC region, focusing on disaster risk analysis and the use of ICTs for disaster risk reduction and management. This model is intended to assist the 16 Member States of SADC in identifying key priorities in terms of their NETP. ITU and the SADC Secretariat co-organized the SADC Model NETP Situational Analysis Validation Workshop on 22-24 March 2023. The workshop focused on the topic of ICTs and disaster management and highlighted topics including NETP, the Tampere Convention, disaster preparedness and investment, EWSs and the UN Early warnings for all initiatives, ITU capacity building opportunities (presented by the ITU Academy team), and regulation. The workshop also validated the SADC NETP situational analysis, an assessment carried out by ITU to identify key priorities and gaps in terms of emergency telecommunication of the SADC Member States. This model will assist the 16 Member States of SADC in identifying key priorities in terms of their NETP.

ITU conducted a stakeholder consultation meeting on 9 March 2023, to draft a NETP as a part of continued assistance to Tonga following the loss of connectivity in the wake of the volcanic eruption in January 2022. Following the formal consultation process, the Tonga Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change, and Communications (MEIDECC) adopted the NETP ahead of the cyclone season that usually starts in the Pacific in October. Technical assistance is supported through an ongoing partnership with the Ministry of Internal Affairs and Communications (MIC) of Japan. To further support countries in developing NETPs, ITU undertook baseline assessments to identify the availability of national laws, regulations and policies governing emergency telecommunications within the Member States of the Arab and Americas , and Pacific Islands regions. ITU has started to support the African Anglophone countries with a similar NETP model that will benefit them. In the same line, ITU is also supporting Saint Vincent and the Grenadines, as well as Georgia with the development of a NETP with a focus on the implementation of EWS. ITU BDT is also supporting the Government of Moldova in the technical, economic and regulatory analysis for the implementation of an EWS based on CB and other means of alert diffusion, such as radio and television broadcasting. This support is provided to Moldova in response to their request made during the Regional Development Forum 2023, and in line with the ITU role as lead on Pillar 3 on 'Warning Dissemination and Communication' of the Early Warning for All Initiative. As part of this support, the implementation of a tailored NETP for Namibia, and the NETPs for Saint Vincent and the Grenadines, and for Georgia were finalized. Furthermore, the implementation of tailored NETPs for Tanzania, Zimbabwe, and Comoros are being finalized, along with the NETPs for State of Libya and Islamic Republic of Mauritania. A NETP for Djibouti has been finalized and is in the process of validation by the national stakeholders. The development of NETPs for Republic of the Gambia, and Republic of Cabo Verde were expected to be finalized by the end of 2024. ITU BDT is also supporting the governments of Somalia, Republic of Zambia, Seychelles, and Botswana in a technical, economic and regulatory assessment for the implementation of an EWS based on CB and other means of alert diffusion, such as radio and television broadcasting as well as sirens. This support is being provided in line with the ITU role as lead on Pillar 3 on 'Warning Dissemination and Communication' of the EW4All Initiative.

Common alerting protocol (CAP): CAP is the international (ITU Recommendation ITU-T X.1303) standard format for exchanging all-hazard emergency alerts and warnings over all kinds of networks, including digital media. The adoption of CAP is an important step for better disaster management and for setting up EWSs. Since April 2021, during the Humanitarian Networks and Partnerships Week, ITU together with International Federation of Red Cross and Red Crescent Societies and WMO announced the 'Call to Action on Emergency Alerting'. The goal is that by 2025, all countries are able to enhance their emergency alerting by leveraging the. A CAP HelpDesk is being established, with the aim of supporting country level implementation of CAP through information, methods, and tools to promote coordination and build a community of support to scale CAP implementation worldwide. ITU participated in the 2022 CAP Implementation workshop, which took place in Amsterdam. A major focus of the workshop was the new UN Secretary-General's goal on protecting every person on Earth with an EWS. ITU met with several countries and experts to discuss how it can support countries and provide technical expertise to ensure that more developing countries adopt a CAP-based EWS, taking advantage of ICTs. ITU BDT participated the CAP Editor Design workshop, 11-12 July, organized by IFRC, and presented how ITU is promoting CAP, the key standard for emergency alerting, to expand the reach of reliable, fast, and actionable early warning messages to people at risk.

Online modules on emergency telecommunications: In January 2021, the ITU launched the ITU Online Training Modules on Emergency Telecommunications. The online training modules have been developed and designed to allow ITU to build capacity and increase knowledge on the topic of emergency telecommunications, and to continue to build disaster resilience, even in times such as the COVID-19 pandemic. The available training modules cover (1) the development of National Emergency Telecommunication Plans (NETPs), which are based on the ITU Guidelines on NETPs, (2) the organization of tabletop simulation exercises (TTX), and (3) information on the Tampere Convention and its benefits. All three online modules are self-paced and are available in the ITU Academy Platform. Since January 2022, the numbers of participants that have taken the courses were: TTX = 79; 10 had earned the badge. Tampere = 46; 7 had earned the badge. NETPs = 122; 18 had earned the badge.

ARCO framework – Arab States region. In March 2021, ITU BDT and the Arab Red Crescent and Red Cross Organization (ARCO) signed the Framework Cooperation Agreement (FCA) to reinforce cooperation to leverage the power of ICTs for disaster risk reduction and management in the Arab region. The objective of the FCA was to further strengthen the partnership between ITU and ARCO to identify the best ICT technologies to be used to interconnect the emergency centres of the national societies and authorities in all Arab countries. Within the framework of this collaboration with ARCO, in November 2021, BDT started an ICT technical assessment to interconnect the ARCO Arab Disaster Preparedness Centre (ADPC) with Arab Red Crescent and Red Cross National Societies, and to be better prepared to respond to disasters and pandemics. The outcome of this assessment will serve as a first step towards developing a regional project to be implemented in cooperation with ARCO and other partners, and to connect the ADPC with Arab disaster authorities and emergency centres of national societies and authorities in all Arab States. The study is now under review by the regional office.

Disaster response

Disaster response: On 16 December 2021, the Philippines was hit by Typhoon Rai/Odette, which brought torrential rains, violent winds, landslides, and storm surges affecting eight million people, and caused extensive damage to infrastructure, including communication services. Following the request from the country, and in cooperation with the WFP Emergency Telecommunication Cluster (ETC), ITU is providing support through the Disaster Connectivity Map (DCM), which tracks connectivity gaps and outages. ITU BDT continues to support Tonga since it was hit by disaster in January 2022. In Tonga, a small island developing state (SIDS) in the Pacific, the eruption of the Hunga-Tonga-Hunga-Ha-pai underwater volcano and subsequent tsunami, caused significant damage across the Tongatapu and Ha'apai Islands, impacting more than 80 per cent of the population of Tonga. The connectivity situation was particularly critical in Tonga as it was cut off from almost all Internet services because the submarine cable that it relies on was damaged and took weeks to be repaired. The situation highlights the importance of connectivity, but also of resilient infrastructure, including through

satellite technology. ITU provided satellite equipment and airtime, and continues to track connectivity through the DCM. Response efforts were complicated by COVID-19, and national regulations, as well as a commercial dispute. Following a request from Nicaragua, ITU deployed 10 Iridium satellite phones and 10 Inmarsat broadband global area networks (BGANs) to support the country in their relief efforts following Hurricane Julia. Two experts from the ITU Emergency Telecommunications Roster were deployed to deliver equipment and train local teams on how to use it. The experts also visited the affected area and supported the response on the field. Following requests from Malawi and Mozambique, the emergency telecommunications team deployed 25 Thuraya satellite phones to Malawi and 10 Iridium satellite phones to Mozambique in support of the disaster response to Cyclone Freddy. Cyclone Freddy broke the record as the longest-lasting tropical cyclone on record. The heavy rainfall brought floods and mudslides, resulting in loss of life and damage to property and infrastructure. More than 200 people died and over 1 million people were affected. Following a request from Papua New Guinea, on 7 August 2023, ITU deployed satellite telecommunications equipment to support the country in the aftermath of the volcanic eruption of Mount Bagana, in Bougainville. This equipment was used to coordinate evacuation activities of all at risk communities, that lived near the volcano, to evacuation/care centres located in Central and South Bougainville. The evacuation was undertaken in coordination with the Autonomous Bougainville Government. The satellite equipment deployed was composed of 10 Iridium satellite phones and 5 Inmarsat BGAN terminals.

A new initiative for pre-positioning ITU satellite equipment was launched in 2023. The aim is to reduce response times in the aftermath of disasters so that countries can restore communication links and provide a fast response to affected communities. At the end of 2023, and the beginning of 2024, equipment was pre-positioned in the WFP ETC warehouse in Dubai to assist Arab States, Africa, and Asia and Pacific regions. Equipment is also pre-positioned in Barbados, which serves as the hub for the Americas region, including the Caribbean Islands, and more equipment is pre-positioned in Zimbabwe to serve the SADC countries. All of these regions have strengthened their preparedness measures and increased capacity to respond to disaster events. In the aftermath of disasters, ITU deploys telecommunications equipment to affected countries to help in restoring telecommunications links which are vital for coordination of the disaster response activities at ground level. The latest deployment was made in Jamaica, Grenada and Saint Vincent and the Grenadines, in July 2024, to support the disaster response to Hurricane Beryl. Also, as part of the preparedness actions, BDT launched a new initiative for pre-positioning ITU satellite equipment. The aim is to reduce response times in the aftermath of disasters so that countries can restore communication links and provide a fast response to affected communities. Equipment has been pre-positioned at WFP ETC warehouse in Dubai to assist countries in the Arab States Asia-Pacific, and Africa regions; in Zimbabwe, at POTRAZ, where equipment will serve the SADC Member States, and in Barbados to assist the Caribbean countries, as well as the Americas region. In July 2024, the ITU satellite equipment was pre-positioned.

ITU Emergency Telecommunication Roster: The ITU Emergency Telecommunication Roster, is a group of ITU expert staff, established in March 2022, that are on-standby to be deployed in times of disasters to deliver emergency telecommunication equipment to countries, and provide training on how to use the Hughes BGAN terminals that were part of the Inmarsat/Hughes donation that ITU BDT recently received. The donation includes 30 broadband global area network terminals (BGANs) and over USD 1.2 million in airtime and training. The BGANs are the size of a laptop and provide Internet and phone services to users. In September 2022, the ITU Emergency Telecommunication team and one member of the Emergency Telecommunication Roster participated the 'Gear.UP' training course in Neuhausen, Federal Republic of Germany. Gear.Up is a large-scale inter-agency operational exercise and functional training event designed to advance the emergency response capabilities of the global ICT and logistics humanitarian community, organized by a key partner of ITU, the Emergency Telecommunication Cluster (ETC).

Disaster Connectivity Map (DCM): The Disaster Connectivity Map is a joint initiative between ITU and the Emergency Telecommunications Cluster (ETC) with input from GSMA, which was initiated in 2020, and consists of a live map that can provide information on the type, level, and quality of connectivity

available on the ground during times of disasters. The DCM team continues testing and evaluating additional connectivity data sources, developing a high-resolution mobile coverage platform and adding filters to further refine the accuracy of the data that is displayed. In February 2022, ITU and ETC held a webinar on the latest developments in the Disaster Connectivity Maps (DCMs) to Global ETC partners. ITU activated the DCM in response to the earthquake that hit Türkiye and Syrian Arab Republic on 6 February 2023. The DCM, which produces near-live data to identify connectivity gaps and outages following disasters, was presented to partners and first responders of the Emergency Telecommunications Cluster (ETC) and was accessed almost 1 000 times from 42 countries during the first two weeks of February 2023, mainly from inside Türkiye. The DCM data showed a significant decrease in network coverage where connectivity immediately after the earthquake stood at 79 per cent of the normal cellular coverage, with outages mostly in less populated rural areas. This period was followed by a steady recovery to over 90 per cent of pre-disaster coverage, with some pockets remaining where connectivity was not detected when compared to normal operation. The DCM was activated to support the disaster relief effort in Vanuatu, that was impacted by tropical Cyclones Judy and Kevin, both of category 4 intensity. The cyclones made landfall on 1 and 3 March and approximately 250 000 people were affected. The strong winds and substantial amounts of rain caused major flooding, damage to buildings and infrastructure, and power outages and communication system breakdowns. A decrease in cellular connectivity coverage area was detected after both cyclones, reaching 36 per cent of the normal level on 3 March, followed by an overall increase during the week from 6 March. ITU activated the DCM in response to the earthquake that hit Morocco on 8 September 2023, to find out which were the areas where mobile networks and services were most affected.

On 26 October 2023, a presentation on DCM was delivered to the NetHope Global Summit in Bridgetown, Barbados, highlighting the new features, data sources, and activations added to the DCM. A 'ground truth exercise' was undertaken with colleagues and partners from ITU, GSMA, ETC and Ericsson, to include measurements taken using the Speedchecker mobile app during the Caribbean multi-stakeholder workshop on the 'Role of Telecommunications in disaster preparedness, response and recovery', which was jointly organized by the ITU, GSMA and WFP/ETC from 21- 23 November 2023. In 2024 the DCM was activated in:

- Mozambique | 3 – 24 Mar 2024
- Madagascar | 26 Mar – 9 Apr
- Grenada and Saint Vincent and the Grenadines to support the response to Hurricane Beryl | June 2024
- In 2024, the DCM was showcased or demonstrated on various events, including:
 - ITU Study Group 12 Mozambique workshop (27 Feb 2024).
 - EW4All Fiji workshop (28 Feb 2024).
 - ITU Study Group 12 Geneva workshop (23 Apr 2024).
 - ITU AI4Good Summit.

Annex 2 – Related work of other sectors

A2.1 Collaboration with other Questions in ITU-D Study Groups 1 and 2

This section provides a list matching ITU-D Question 3/1 to other Questions being examined by ITU-D Study Groups 1 and 2. The list was reviewed and discussed at Question 3/1 meetings, after which the table below was agreed without any further comments.

Table A-8: Matrix of ITU-D Study Group 1 and 2 intra-sector coordination

	Q1/1	Q2/1	Q4/1	Q5/1	Q6/1	Q7/1	Q1/2	Q2/2	Q3/2	Q4/2	Q5/2	Q6/2	Q7/2
Q3/1	X	X	X	X			X	X	X		X	X	

A2.2 Mapping of ITU-T and ITU-D Questions²⁵⁶

An updated mapping is provided below, based on ITU Study groups activities, and existing mapping table provided Inter-Sector Coordination Group (ISCG).

A2.3 Mapping of ITU-R Working Parties and ITU-D Questions²⁵⁷

The mapping with ITU-R is detailed below.

²⁵⁶ <https://www.itu.int/en/general-secretariat/ties/ISCGDocumentLibrary/Liaisons%20Statements%20on%20Inter-Sectoral%20Coordination%20Activities/Table%203.pdf>

²⁵⁷ <https://www.itu.int/en/general-secretariat/ties/ISCGDocumentLibrary/Liaisons%20Statements%20on%20Inter-Sectoral%20Coordination%20Activities/Table%201.pdf>

Annex 3 – Information from ITU-T, ITU-R and other organizations

A3.1 AI for natural disaster management (ITU-T Study Group 2)²⁵⁸

ITU-T Study Group 2 reported on the progress of our activities on disaster risk reduction and management. ITU-T SG2 is the lead study group on telecommunications for disaster relief/early warning, network resilience, and recovery, and presently parents the Focus Group on AI for Natural Disaster Management (FG-AI4NDM). FG-AI4NDM completed the following deliverables which were approved by the focus group:

- SG2-TD192/PLEN²⁵⁹ is a Technical Report for AI for Communications Towards Natural Disaster Management
- SG2-TD191/PLEN²⁶⁰ is a Technical Report for Standardization Roadmap on Natural Disaster Management Trends and Gaps in Standardization
- SG2-TD193/PLEN²⁶¹ Glossary for Artificial Intelligence for Natural Disaster Management

The ITU Telecommunication Standardization Bureau (TSB) will add the above documents to the focus group page for deliverables, alongside the previous deliverables from the Focus Group on Disaster Relief Systems, Network Resilience and Recovery (FG-DR&NRR): <https://www.itu.int/pub/T-FG>.

FG-AI4NDM has the following working groups:

Table A-9: Working Groups in FG-AI4NDM

Working Group on Data for AI (WG-Data)	WG-Data looks at best practices for data collection, handling, and monitoring. It is responsible for producing the technical report on this topic.
Working Group on AI for Modelling (WG-Modelling)	WG-Modelling explores the application of AI to support modelling across spatiotemporal scales through extracting complex patterns (and gaining insights) from a growing volume of geospatial data as well as aspects such as data preparation for training, AI development, and AI evaluation. It is responsible for producing the technical report on this topic.
Working Group on AI for Communications (WG-Comms)	WG-Comms addresses the role of AI in facilitating effective communications before and during natural disasters. It looks at technical as well as sociological/demographical aspects. It is responsible for producing the technical report on this topic.

²⁵⁸ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0050/> from ITU-T SG2.

²⁵⁹ <https://www.itu.int/md/meetingdoc.asp?lang=en&parent=T22-SG02-230313-TD-PLEN-0192>

²⁶⁰ <https://www.itu.int/md/meetingdoc.asp?lang=en&parent=T22-SG02-230313-TD-PLEN-0191>

²⁶¹ <https://www.itu.int/md/meetingdoc.asp?lang=en&parent=T22-SG02-230313-TD-PLEN-0193>

Table A-9: Working Groups in FG-AI4NDM (continued)

Working Group for Mapping AI-related Activities in Natural Disaster Management (WG-Roadmap)	WG-Roadmap compiles information about pre-standardization and standardization activities in the field of AI for natural disaster management (focusing on standard developing organizations and UN bodies). It is responsible for producing the roadmap.
Working Group on Educational Materials to Support Capacity Building (WG-EduMat)	WG-EduMat looks at the activities of the working groups and work streams, extracts components that are deemed relevant for different target stakeholders (with a focus on least developed countries and small island developing states), and produces educational materials using various formats that can transfer this knowledge. It is responsible for producing the educational materials.

Additional information about FG-AI4NDM can be found at: <https://www.itu.int/en/ITU-T/focusgroups/ai4ndm/Pages/default.aspx>

A3.2 Informative update in the area of disaster communications (ITU-R Disaster Relief Liaison Rapporteur)²⁶²

The ITU-R Disaster Relief Liaison Rapporteur frequently provided updated information related to disaster communications in ITU-R and other organizations.

Telecommunication is critical at all phases of disaster management. Aspects of radiocommunication services associated with disasters include, inter alia, disaster prediction, detection, alerting and relief. In certain cases, when the "wired" telecommunication infrastructure is significantly or completely destroyed by a disaster, only radiocommunication services may be employed for disaster relief operation.

Two major tasks of the ITU-R - ensuring the effective use of the radio-frequency spectrum, and studies concerning development of radiocommunication systems- concern all radiocommunication services. Moreover, the ITU-R SGs carry out studies related to the continuing development of radiocommunication systems used in disaster mitigation/relief operations and these can be found within their work programmes. ITU-R SG 5 Webpage Emergency Radiocommunications indicates the diverse ITU-R SGs activities on Prediction & Detection at SG 7, Alerting at SG 4, SG 5 and SG 6, Relief at SG 4, SG 5 SG 6 and SG 7.

ITU Radio Regulations Resolution 646 (Rev.WRC-19) 'Public protection and disaster relief' encourages membership to use harmonized frequency ranges for public protection and disaster relief (PPDR) to the maximum extent possible when undertaking their national planning for their PPDR applications. Recommendation ITU-R M.2015 'Frequency arrangements for public protection and disaster relief radiocommunication systems in accordance with Resolution 646 (Rev.WRC-15)' is most relevant to the Q3/1 Report. It promotes and provides guidance on global and regional harmonization of frequency bands for PPDR. The combination of Resolution 646 (Rev.WRC-19) and other relevant ITU-R

²⁶² ITU-D Document <https://www.itu.int/md/D22-SG01-C-0176> from ITU-R WP5A and ITU-D Documents <https://www.itu.int/md/D22-SG01-C-0007/>, <https://www.itu.int/md/D22-SG01-C-0021/>, <https://www.itu.int/md/D22-SG01-C-0062/>, <https://www.itu.int/md/D22-SG01-C-0171> and <https://www.itu.int/md/D22-SG01-C-0548> from ITU-R Disaster Relief Liaison Rapporteur.

Recommendations and Reports serve as a package in relation to the provision of PPDR services and applications.

A3.3 Terrestrial broadcasting delivery for disaster relief (ITU-R Working Party 6A)^{263 264}

1) HF broadcasting bands

ITU-R WP6A informed that it has developed a draft revision of Recommendation ITU-R BS.2107, "Use of International Radio for Disaster Relief (IRDR) frequencies for emergency broadcasts in the High Frequency (HF) bands," and lists the HF frequencies reserved in the HF broadcasting bands for emergency broadcasts.

2) Satellite and terrestrial broadcasting systems

ITU-R WP6A informed Recommendation BT/BO.1774²⁶⁵ "Use of satellite and terrestrial broadcast infrastructures for public warning, disaster mitigation and relief". The Recommendation provides characteristics of satellite and terrestrial broadcasting systems used for disaster mitigation and relief operations. Detailed descriptions of these systems are given in Annex 1 of the Recommendation as guidance.

3) Joint ITU-R SG 6 – EBU Workshop

ITU-R WP6A provided information on Joint ITU-R SG 6 – EBU Workshop²⁶⁶ "Broadcasting in times of crisis- 2023". The main objectives of this workshop were to remind about the role of broadcasting in times of crisis, through real-life examples; to inform about available emergency warning technologies in broadcasting and their synergy with other radiocommunication systems, and to identify high-level requirements to improve the role of broadcasting in this context.

4) Broadcasting for public warning, disaster mitigation, and relief

ITU-R WP6A also provided reference to ITU-R Report BT.2299²⁶⁷ "Broadcasting for public warning, disaster mitigation and relief". The Report explains the criticality of radio and television broadcasting media for information dissemination to the public in times of emergencies. Indeed, fixed, mobile and portable terrestrial broadcast receivers are readily available, inexpensive, and virtually ubiquitous in most societies. The case studies in this Report represent only a few of countless examples that attest to the global importance of terrestrial broadcasting, helping to protect and save lives during local, national and international emergencies.

A3.4 Early warning systems using radiocommunication systems (APT ASTAP)²⁶⁸

APT Standardization Programme (ASTAP) Expert Group Disaster Risk Management and Relief Systems (EG DRMRS) has already published an APT Recommendation, APT/ASTAP/REC-01 (Rev.1), and an APT

²⁶³ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0037/> from ITU-R WP6A.

²⁶⁴ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0496/> from ITU-R WP6A.

²⁶⁵ <https://www.itu.int/rec/R-REC-BT/recommendation.asp?lang=en&parent=R-REC-BT.1774>

²⁶⁶ <https://1f8a81b9b0707b63-19211.webchannel-proxy.scarabresearch.com/en/ITU-R/study-groups/workshops/sg6-itu-ebu-btc-2023/Pages/default.aspx>

²⁶⁷ <https://www.itu.int/pub/publications.aspx?lang=en&parent=R-REP-BT.2299-3-2022>

²⁶⁸ ITU-D SG1 Document <https://www.itu.int/md/D22-SG01.RGQ-C-0120/> from APT.

report, APT/ASTAP/REPT-02, which relate to EWSs using radiocommunication systems. EG DRMRS believes these APT documents help to develop a work plan, especially for EWSs.

In addition, ASTAP has already published the following APT reports on the disaster management area:

- APT Report on a Cost-Effective Disaster Management System.
- APT Report on a Disaster Information Sharing System in APT Countries.
- APT Report on Requirements of an Information and Communication System Using Vehicle during Disaster.
- APT Report on case studies for portable/movable emergency telecommunication systems in APT region.
- APT report on local-area resilient information sharing and communication systems.

A3.5 Characteristics of fibre-optic submarine cable systems (ITU-T Study Group 15)^{269, 270}

The following work items related to the use of telecommunications/ICTs for disaster risk reduction and management are currently under study within Questions of ITU-T SG15.

- Question 7/15: The revised version of Recommendation ITU-T L.250²⁷¹ (01/2024): Topologies for optical access network – has been published. Descriptions of the topology reliability have been added in the revision work. In clause 9, the physical network topology that can withstand disaster using redundant architecture at the optical fibre /cable level were mentioned in the revised version.

Recommendation ITU-T L.391/L.81²⁷² (11/2009): Monitoring systems for outside plant facilities – is currently under revision. In clause 6.3, descriptions of the additional emergency management programme for "freezing" will be added in this revision work. The revised version will also describe the distributed fibre-optic sensing technique as a useful technique for detecting the disaster.

- Question 8/15: The new Recommendation ITU-T G.9730.1²⁷³ (08/2024): Dedicated scientific sensing submarine cable system – has been published. The new Recommendation addresses the dedicated submarine cable system for scientific sensing applications for climate monitoring and disaster risk reduction.

The new Recommendation ITU-T G.9730.2²⁷⁴ (08/2024): Scientific monitoring and reliable telecommunication submarine cable systems – has been published. The new Recommendation describes the qualitative high-level characteristics

²⁶⁹ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0123> from ITU-T SG15.

²⁷⁰ ITU-D SG1 Document <https://www.itu.int/md/D22-SG01-C-0509/> from ITU-T SG15.

²⁷¹ <https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=15808>

²⁷² <https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=10435>

²⁷³ <https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=16050>

²⁷⁴ <https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=16051>

and requirements of scientific monitoring and reliable telecommunication cables using fibre-optic submarine cables to enable both telecommunication and sensing functionalities for ocean and climate monitoring as well as disaster warning. The implementation of seismic, accelerometer, absolute pressure gauge sensors as well as distributed acoustic sensing (DAS) within a submarine cable system could be used for early tsunami warning.

A3.6 Rapid response to sudden natural disasters in network (ITU-T Study Group 11)²⁷⁵

The following work items related to the use of telecommunications/ICTs for disaster risk reduction and management are currently under study within Questions of ITU-T SG11.

ITU-T Q.Reg_Frame_RRDN specifies the requirements and framework for rapid response to sudden natural disasters. The scope of the draft Recommendation includes:

- 1) The requirements for the network capability to realize rapid response to sudden natural disasters, which reduce rescue time and increase rescue effectiveness and success.
- 2) The framework of the network enables the rapid response system to achieve a series of functions.
- 3) Security considerations.

The draft ITU-T Q.Reg_Frame_RRDN is available in SG11-TD1102/GEN²⁷⁶.

A3.7 Emergency telecommunication specifications (ETSI TC EMTEL)²⁷⁷

The following work items related to the use of telecommunications/ICTs for disaster risk reduction and management are currently under study within ETSI TC EMTEL.

The Table A-12 lists the specifications and report published by TC EMTEL on these topics.

Table A-10: The specifications and report of TC EMTEL

Category title	Explanation
Acronym	– ETSI TR 102 445 v1.2.1 – ETSI TS 102 181 v1.3.1 – ETSI TS 102 182 v1.5.1 – ETSI TS 102 900 v1.4.1
ETSI	ETSI/Technical Committee EMTEL (Emergency Communications)

²⁷⁵ ITU-D Documents <https://www.itu.int/md/D22-SG01-C-0113/>, <https://www.itu.int/md/D22-SG01-C-0276/> and <https://www.itu.int/md/D22-SG01.RGQ-C-0144/> from ITU-T SG11.

²⁷⁶ <https://www.itu.int/md/T22-SG11-240501-TD-GEN-1102/en>

²⁷⁷ ITU-D Documents <https://www.itu.int/md/D22-SG01-C-0114/> and <https://www.itu.int/md/D22-SG01-C-0277/> from ETSI TC EMTEL.

Table A-10: The specifications and report of TC EMTEL (continued)

Category title	Explanation
Title	– Emergency Communications (EMTEL); Overview of emergency communications network resilience and preparedness – Emergency Communications (EMTEL); Requirements for communication between authorities/organizations during emergencies – Emergency Communications (EMTEL); Requirements for communications from authorities/organizations to individuals, groups or the general public during emergencies – Emergency Communications (EMTEL); European public warning system (EU-ALERT) using the cell broadcast service
Description	TS 102 900 and TS 102 182 cover communication from authorities to citizens, e.g. Public Warning System. TS 102 181 defines the requirements for communication between authorities/organizations during emergencies. The last version published in June 2020 includes activities on mission critical services (MCX), satellite and IoT for emergency communication. TR 102 445 focuses on the concepts of resilience and preparedness including more recent communication network technologies used by emergency services. TS 102 900 covers communication from authorities to citizens, e.g. Public Warning System. The changes are to add support for device-based geo-fencing to EU-Alert, and may support alerts with the default device audio attention signal and default device vibration cadence, and support of alerts that are silent (no audio attention signal and no vibration cadence).
Main disaster group	The work done by ETSI TC EMTEL does not differentiate between disaster groups.
Disaster management phase	These ETSI EMTEL published documents cover the mitigation, preparedness and response phases of the disaster management cycle.
Relevant technologies	Early warning system
Status	Published.
Link	https://www.etsi.org/deliver/etsi_ts/102900_102999/102900/01.04.01_60/ts_102900v010401p.pdf https://www.etsi.org/deliver/etsi_ts/102100_102199/102182/01.05.01_60/ts_102182v010501p.pdf https://www.etsi.org/deliver/etsi_ts/102100_102199/102181/01.03.01_60/ts_102181v010301p.pdf https://www.etsi.org/deliver/etsi_tr/102400_102499/102445/01.02.01_60/tr_102445v010201p.pdf
Contact	Cristina Lumbreras (cl@eena.org), TC EMTEL Chair. Peter Sanders (peter.sanders@everbridge.com), TC EMTEL Vice Chair and Rapporteur for early warning system.

A3.8 Emergency services (ITU-T Study Group 16²⁷⁸ and ITU-T Study Group 21^{279 280})

The following work items related to the use of telecommunications/ICTs for disaster risk reduction and management are currently under study within Questions of ITU-T SG21.

Table A-11: Newly developing work items related to disaster management in ITU-T SG16

Work item	Question	Subject / Title	Timing	Reference(s)
H.430.3 (V2)	Q8/21 (ex Q8/16)	Live streaming service in inaccessible areas scenarios	*	SG16-TD138/Plen
H.ILE-AR	Q8/21 (ex Q8/16)	Augmented reality assisted immersive live experience, including ILE-AR for disaster response (ILE-AR4DR)	2026	SG21-TD11/WP4
F.CUAV-ES	Q9/21 (ex Q21/16)	Framework and requirements for emergency services using civilian unmanned aircraft vehicles	2024	SG16-TD160/WP1 (2023-07)
F.760.2 (ex F.FR-ERSS)	Q4/21 (ex Q24/16)	Requirements for user interface of first responders in emergency response support systems	**	SG16-TD175-R2/Plen (2023-07)
F.MDI	Q4/16 (ex Q24/16)	Metadata for disaster information presentation with human factors	2023	SG16-TD68/WP2 (2023-07)
F.760.1 (ex F.EMRESCUE)	Q2/21 (ex Q28/16)	Requirements and reference framework for emergency rescue systems	2022	Published

A3.9 International mobile telecommunications (IMT) for broadband public protection and disaster relief (PPDR)(ITU-R Working Party 5D)^{281 282}

WP 5D suggests that Report [ITU-R M.2291](#) on the use of international mobile telecommunications (IMT) for broadband public protection and disaster relief (PPDR) applications, should be considered while working on the new Report on the use of telecommunications/ICTs for disaster risk reduction and management.

Report [ITU-R M.2291](#) on use of IMT for broadband PPDR applications, addresses how IMT-based technologies could play a vital role by enabling broadband PPDR applications. PPDR communications are predominantly mission critical because they aid in ensuring the protection and safety of life or property on a day-to-day basis, as well as in response, rescue, and recovery efforts before, during, and

²⁷⁸ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0120/> from ITU-T SG16.

²⁷⁹ ITU-T Study Group 21 (SG21) was established by World Telecommunication Standard Assembly held in October 2024 (WTSA-24), and merged ITU-T SG16 and SG9. All work in previous SGs9 and 16 were continued in SG21.

²⁸⁰ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0473/> from ITU-T SG21 (Technologies for multimedia, content delivery and cable television).

²⁸¹ ITU-D Document <https://www.itu.int/md/D22-SG01.RGQ-C-0146/> from ITU-R WP5D.

²⁸² ITU-D Document <https://www.itu.int/md/D22-SG01-C-0477/> from ITU-R WP5D.

after emergencies and disasters. The ability of PPDR agencies to react quickly, to inter-communicate, and to work together in close coordination with each other, as well as their ability to communicate with resources that are farther away, will heavily influence the outcome of an emergency, whether it be a forest fire, a traffic accident, or a terrorist threat. With the ever-increasing scale of responses to emergency situations, and increased numbers of responding agencies and authorities, administrations have increasingly recognized how new PPDR applications based on IMT systems may be able to serve or support broadband PPDR communications. The use of IMT for broadband PPDR applications could open up new ways of working, increase the effectiveness of emergency management, and improve interaction within and across PPDR organizations. Section 3 of Report ITU-R M.2291, details the existing and planned capabilities of IMT that support broadband PPDR applications, and Section 4 of the Report introduces some of the planned capabilities of IMT-2020 to support broadband PPDR applications.

PPDR applications could be supported on commercial IMT networks to either complement the dedicated PPDR networks in certain areas where dedicated networks may not be economically viable, or to directly integrate PPDR applications, so as to reduce the overall cost of deploying a dedicated PPDR network. Section 5 of the Report details some approaches for supporting broadband PPDR applications using IMT.

A3.10 Development in the HAPS industry and regulatory recommendations to enable the stratospheric ecosystem (HAPS Alliance)^{283 284}

High altitude platform stations (HAPS) as one of the non-terrestrial network (NTN) solutions, constitute an important layer in modern 3D telecommunication infrastructure, together with satellite constellations, and terrestrial networks. HAPS can help telecommunication services providers and government agencies overcome cost and geographic challenges, by expanding coverage to unserved and underserved areas, as well as in rapid response to natural disasters. Due to their lower altitudes compared to satellite systems, faster connection speeds with lower latency, better indoor penetration, and higher network capacity can be achieved.

HAPS Alliance Telecom WG (<https://hapsalliance.org/>) produces deliverables which provide useful information for governments that are planning, or are interested in implementation of HAPS within their national frameworks:

- Unlocking the Potential of the Stratosphere²⁸⁵ (Q2 2024) - Introduces the HAPS Alliance mission and vision, membership, and technological progress, and considers the fundamental technologies and stratospheric platforms progressed by member companies towards commercialization.
- Creating an Enabling Regulatory Environment for HAPS Deployment²⁸⁶ (May 2024) - Regulatory recommendations for HAPS to support the stratospheric ecosystem are provided, including the latest information, such as for example information on the expansion of HAPS service-link following WRC-23 for flexible use of HAPS frequency bands, to assist governments in implementing appropriate HAPS regulations within their national frameworks.

²⁸³ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0402/> from SoftBank.

²⁸⁴ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0499/> from HAPS Alliance.

²⁸⁵ <https://hapsalliance.org/pitch-deck/>

²⁸⁶ <https://hapsalliance.org/publications/>

Additionally, the HAPS Alliance recently published a new White Paper titled "HAPS Reference Architecture Series: Cell Towers in the Sky²⁸⁷", which provides an overview of the aviation and service systems. HAPS Alliance is also in the process of drafting some use cases and technical white papers.

A3.11 Disaster response by Internet of Things (IoT) and disaster prevention for smart sustainable cities and communities (SSC&C) (ITU-T Study Group 20)²⁸⁸

ITU T Study Group 20 (SG20) is responsible for the development of innovative standards (ITU-T Recommendations), guidelines, reports, methodologies and best practices for the Internet of Things (IoT), digital twins, and smart sustainable cities and communities (SSC&C), with the goal of accelerating digital transformation in urban and rural areas.

SG20 provided the following information on published and ongoing specifications related to disaster risk reduction and management:

Table A-12: SG20 work items on disaster risk reduction and management

Work item	Question	Subject / Title	Timing	Reference(s)
ITU-T Y.4705 (ex Y.nmm-isms)	Q1/20	Metadata model of sensing capability for disaster monitoring systems	2024-08	ITU-T Y.4705
ITU-T Y.4226 (ex Y.isms)	Q1/20	Functional framework and requirements for disaster monitoring systems	2024-08	ITU-T Y.4226
ITU-T Y.4222 (ex Y.smart-evacuation)	Q2/20	Framework of smart evacuation in a disaster or emergency in smart cities and communities	2025-01	ITU-T Y.4222
ITU-T Y.4601 (ex Y.dt-smartfirefighting)	Q2/20	Requirements and capability framework of a digital twin for smart firefighting	2023-Q1	ITU-T Y.4601
ITU-T Y.4229 (ex Y.IoT-SFFS)	Q2/20	Requirements and reference functional model for an Internet of things-based smart forest firefighting system	2025-Q1	ITU-T Y.4229
ITU-T Y.Fram-ssdp	Q3/20	Requirements and framework of metaverse simulation service for disaster prevention in electric power facilities	2026-Q4	SG20-TD255
ITU-T Y.4507 (ex Y.arc-psfws)	Q3/20	A functional architecture of Internet of things-based warning system for power supply facilities	2025-Q1	ITU-T Y.4507

²⁸⁷ https://hapsalliance.org/wp-content/uploads/formidable/12/2024_HAPS_Reference_Architecture_Cell_Towers_In_The_Sky_White_Paper.pdf

²⁸⁸ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0466/> from ITU-T Study Group 20.

Table A-12: SG20 work items on disaster risk reduction and management (continued)

Work item	Question	Subject / Title	Timing	Reference(s)
ITU-T Y.Supp-AI-WF	Q4/20	Analysis of AI models and datasets for Cerrado Savana Biome wildfire detection	2026-Q3	SG20-TD352-R2 SG20-TD353-R2
ITU-T Y.4911 (ex Y.KPI-Flood) (determined)	Q7/20	Key performance indicators of ICT based urban flood disaster prevention and mitigation capability	2025-Q4	TD174-R4

A3.12 Implementation of NEPT in Comoros (ITU-T Study Group 2)²⁸⁹

ITU-T Study Group 2 (SG2) informed a related contribution from Comoros, which highlights how telecommunications and ICT technologies have been effectively utilized in Comoros to enhance disaster preparedness, response, and resilience, particularly in the context of natural disasters. The Comoros experience offers valuable insights into the role of ICT in improving disaster management, and these lessons can be of significant value to other regions facing similar challenges.

²⁸⁹ ITU-D Document <https://www.itu.int/md/D22-SG01-C-0469/> from ITU-T Study Group 2.

Annex 4 – Information on workshops and panel sessions

A4.1 Emergency preparedness for disaster management²⁹⁰

A4.1.1 Introduction

As part of the work of **ITU-D Study Group 1 Question 3/1**, a workshop on 'Emergency preparedness for disaster management', took place on 11 May 2023. This workshop aimed to present and exchange information on disaster prediction and detection, emergency alerting, and the use of emerging ICTs for disaster preparedness. The discussion focused on identifying lessons learned based on the experiences of a diverse group of stakeholders. The discussion results will be considered for further study as the Question focuses on EWSs and disaster preparedness, with key findings incorporated into the final report of Question 3/2. All presentations for this session are available on the event website at: <https://www.itu.int/en/ITU-D/Study-Groups/2022-2025/Pages/meetings/session-Q3-1-may23.aspx>.

A4.1.2 Session details

A4.1.2.1 Opening

The workshop was opened by **Ms Alison Balzer (United States), Co-Rapporteur for Question 3/1**, who welcomed participants, then briefly explained the background and objectives of this workshop. **Mr Cosmas L. Zavazava**, BDT Director, had some opening remarks delivered by Ms Vanessa Gray. The BDT director had been involved in the area of disaster management and relief activities in ITU for many years, and so thoroughly recognized the significance of the Q3/1 subject matter as a means of protection for human life in natural disaster events. ITU has continually provided emergency telecommunications support to ITU Member States in the event of disaster, and recently provided satellite phones to Mozambique. As connectivity during disasters is critical, a National Telecommunication Plan (NTP) should be a priority for all countries. All presenters and participants received sincere thanks for their contributions.

A4.1.2.2 Early warning systems for disaster preparedness

This session was moderated by **Ms Alison Balzer. Ms Vanessa Gray (Head of Environment and Emergency Telecommunications division, ITU BDT)**, presented the United Nations Early Warning for All (EW4All) initiative. Established in March 2022, the aim of the EW4All initiative is for all people, everywhere to benefit from an EWS by 2027. ITU plays an important role in communication which is the one of the four pillars of the EW4All initiative. It was informed that mobile phones, owned by roughly 75 per cent of people worldwide, could serve as suitable terminals for early warning messages. EW4All selected 30 countries in which to implement strategies for national EWSs, including training and tools. Due to other business, questions were postponed to Q3/1 rapporteur meeting sessions. **Mr Tom Ward (IBM, United States), vice-chairman of ITU-T Focus Group on AI for Natural Disaster Management (FG-AI4NDM)**, presented remotely an 'Introduction of activities and outcomes of FG-AI4NDM', providing an overview of deliverables made by FG-AI4NDM. This presentation was made in collaboration with **Ms Ivanka Pelivan (Fraunhofer HHI, Germany), vice-chairman of FG-AI4NDM**. An important deliverable titled "AI for effective communication" was published in March, as a deliverable of FG-AI4NDM. He also introduced the management structure and the current status of FG-AI4NDM. Since the FG was extended to 2024, it was suggested to maintain close collaboration between Q3/1 and the FG. **Mr Mike Gerber (NOAA, United States)**, presented "Mobile alerting in the United States of America", which introduced the meteorological messaging system called 'Wireless emergency alert

²⁹⁰ For further information, see the workshop [webpage](#).

(WEA)²⁹¹. Over 1 600 organizations joined the WEA activities, which provides emergency meteorological information, such as hurricane and tornado information in English and Spanish. The system follows the national regulations for wireless systems from by ATIS and 3GPP. **Dr Ken T. Murata (National Institute of Information and Communications Technology (NICT), Japan)**, presented "Visual IoT techniques for resilient natural disaster mitigation", which introduced a disaster detection system using AI and visual surveillance cameras. This system can detect not only wildfires and flooding but also volcanic eruptions. This information including use cases was proposed to the Q3/1 Rapporteur Group meeting.

A4.1.2.3 Q&A session

Mr Serigne Abdou Lahatt Sylla (Senegal), Co-Rapporteur Question 3/1, moderated this Q&A session. In the session, the following questions, mainly concerning the NOAA presentation, were raised and answered:

- The question was raised as to whether the scope of the AI model for meteorological forecasting needed to be clarified. The AI model did not depend on the message types, and over 1 000 systems in several organizations were connected to WEA.
- A United States representative pointed out that implementing WEA was not easy, because several organizations had several different systems. Collaboration with organizations, especially telecommunication providers is necessary.
- A Côte d'Ivoire representative suggested the need to consider accessibility for WEA, especially for blind persons.
- Concerning the NICT presentation, a representative for Kenya suggested that the implementation costs of the visual IoT system needed to be considered. The response was that utilizing commercial off the shelf (COTS) equipment reduced costs, and that users can use their own ICT devices.

A4.1.3 Closing remarks

Mr Serigne Abdou Lahatt Sylla (Senegal), Co-Rapporteur Question 3/1, thanked all the speakers, moderators, participants, and BDT staff and interpreters for their active support and contributions to making the workshop a real success.

A4.2 Disaster management and resilience workshop²⁹¹

The Q3/1 management team organized a workshop on '**Disaster management and resilience through telecommunications/ICT**', which took place at ITU Headquarters in **Geneva, Switzerland, on 25 April 2024**, in conjunction with the Question meeting 3/1 of ITU-D Study Group 1 on "The use of telecommunications/ICT for disaster risk reduction and management". The workshop report is accessible for ITU-D Sector members at: <https://www.itu.int/md/D22-SG01-C-0390/>.

A4.2.1 Presentation of speakers and discussions

The first session, entitled "ICT infrastructure in times of crisis: Strengthening telecommunications networks for disaster resilience," focused on the critical importance of telecommunications

²⁹¹ For further information, see the workshop [webpage](#) and contribution [1/390E](#).

infrastructure in disaster management and strategies, to strengthen the resilience of these networks in times of crisis. Speakers and participants took a close look at the specific challenges faced by telecommunications networks during disasters such as earthquakes, storms, floods and wildfires, as well as solutions and best practices to address them.

In this session, the presentations were summarized in the following points:

- Overview of the challenges facing telecommunications and ICT infrastructures in the event of a disaster.
- Exploring network preparedness and hardening strategies, including telecommunications and ICT infrastructure resilience, diversification of communication channels, and emergency response plans.
- Case studies in disaster communication network management.

The second session, entitled "Technological innovation and cooperation: Information and communication technologies as key tools in emergency management and post-disaster reconstruction", examined the crucial role of ICTs in emergency management and post-disaster reconstruction. During the discussions, speakers highlighted the latest technological innovations and best practices in the use of ICTs to effectively respond to crises, and facilitate the sustainable reconstruction of affected communities.

The points discussed in this second session mainly revolved around:

- The introduction of innovative technologies such as artificial intelligence (AI), Internet of Things (IoT), and big data analytics for disaster management.
- Discussion on the importance of collaboration between governments, humanitarian organizations, the private sector, and civil society in the use of ICT for disaster prevention, emergency response, and reconstruction.
- Presentation of innovative applications and platforms using ICT for real-time data collection, mapping of affected areas, and coordination of relief operations.

A4.2.2 Conclusions of the workshop

In conclusion, the ITU-D Question 3/1 team reiterated its thanks to the speakers, participants and the BDT team. Participants expressed their appreciation for the informative experiences shared. The need for good collaboration and effective coordination between governments, humanitarian organizations, the private sector, and civil society in the use of Telecommunications/ICTs for disaster risk reduction and management, was highlighted in the various interventions. The importance of continuing to introduce innovative technologies such as artificial intelligence, Internet of Things (IoT), and big data analytics in disaster management is encouraged in disaster prevention and resilience initiatives.

A4.2.3 Detailed report of the workshop

Report of the workshop organized by ITU-D Question 3/1 on 25 April 2024, in Geneva.

Welcome and setting the scene

The workshop commenced with an opening address by Mr Serigne Abdou Lahatt Sylla (Senegal), Co-Rapporteur of ITU-D Study Group 1 Question 3/1. He highlighted the negative impact of disasters on populations and the disruption to social and economic life caused by such events. He also

emphasised the central role that telecommunications and ICTs play in disaster prevention, mitigation, and management. He indicated that the main objective of the workshop is to exchange experiences and knowledge on disaster resilience mechanisms using telecommunications/ICTs (5G, the Internet of Things, megadata and artificial intelligence) with ITU-D Sector members. Finally, he reiterated that the outcomes of the discussions could be valuable for the preparation of the annual report on Question 3/1. He also expressed his gratitude to the speakers, focal points, and BDT team for their contributions to the success of the workshop. These thanks were echoed by Ms Alison Balzer (United States), Co-rapporteur for ITU-D Question 3/1, to the speakers, the focal points, and the BDT team.

SESSION 1 – ICT infrastructure in times of crisis: Strengthening telecommunication networks for disaster resilience

Session 1 began with introductory remarks by the moderators, Mr Serigne Abdou Lahatt SYLLA (Senegal) and Ms Alison Balzer (United States) co-rapporteurs for ITU-D Question 3/1.

Ms Zoe Hamilton from GSMA highlighted three key areas that past communication networks focused on to increase resilience: internal organization, external coordination, and collaboration with humanitarian entities. Internally, businesses developed continuity management plans, ensured staff safety, and conducted drills. They secured access to key sites, maintained infrastructure, and prepared backup power systems. Externally, operators supported customers with services such as free credit and Wi-Fi, coordinated with suppliers, and worked with governments to remove regulatory barriers. Finally, collaboration with the humanitarian community, including coordination with responders and other mobile network operators, proved essential for national resilience. Mobile network operators collaborate with governments to develop national emergency telecommunication plans, identifying potential roadblocks in advance. These include issues such as the importing of necessary equipment, power, and generators, and establishing roaming agreements. By addressing these pain points early, both government and industry can ensure swift network restoration during crises, benefiting responders and the public. The GSMA representative also emphasized three main barriers to enhancing communication network resilience: cost, coordination, and geographic challenges. The GSMA representative highlighted the financial burden of setting up and maintaining resilient infrastructure and stressed the need for broader funding sources beyond traditional government budgets. The GSMA also sees positive trends in increased focus on resilience initiatives and coordination efforts across sectors and organizations, despite challenges in cultural and operational alignment. GSMA advocates for proactive planning and innovative solutions, such as mobile base stations on ships and cloud-based EWSs, to address remote and vulnerable areas effectively. The GSMA representative also touched upon the Humanitarian Connectivity Charter, an initiative in the mobile industry, focused on enhancing disaster preparedness and resilience among mobile network operators. GSMA facilitates knowledge sharing and coordination among operators, governments, and humanitarian actors through workshops and country-specific collaborations. Their efforts include conducting research to document best practices and protocols for setting up communication mechanisms in crisis situations. Recently expanding into crisis and conflict settings, GSMA addresses challenges such as intentional infrastructure targeting and network shutdowns, emphasizing the critical need for coordinated efforts to maintain connectivity during emergencies.

Mr Justin Cain from the Federal Communications Commission (FCC) explained that preparedness and resilience are closely linked. Effective response relies on understanding infrastructure availability, particularly in underserved areas, and ensuring network redundancy. This involves planning for disaster scenarios, learning from past events such as hurricanes and 9/11, and collaborating with agencies and the industry to enhance communication capabilities during disasters. A key point in disaster management is maintaining communication through mutual aid among industry players. Initiatives such as the Emergency Cooperative Communication Network, started in 2016, and the mandatory Disaster Response Initiative, require carriers to enable roaming on each other's networks during disasters. The FCC mandates carriers to report outages and establishes pre-agreements to ensure technical feasibility. This collaboration ensures communication consistency and resource sharing during disasters, recognizing that communication providers are also impacted. The FCC also

grants waivers and special authorizations, to facilitate mobile solutions during such events. He also explained that the FCC had taken actions to ensure service prioritization when most needed. The FCC implemented telecommunication service prioritization, identifying critical nodes across the United States that, if impacted, could affect the public significantly. By registering these nodes with the Cybersecurity and Infrastructure Security Agency, the industry focused on restoring them first during disasters. Additionally, the wireless priority service (WPS) gave disaster management, national security, and law enforcement personnel priority access in congested or degraded environments, ensuring essential communications were maintained for the country's stability and security. Finally, he highlighted the crucial role of regulators in all facets of disaster planning and preparedness, ensuring they understand technical challenges faced by telecommunications carriers and enabling informed policy decisions to support effective communication and response efforts for residents, first responders, and law enforcement.

Ms Ria Sen from World Food Programme shared findings from a study²⁹² indicating that for every USD dollar invested in disaster preparedness, there is a threefold saving in response costs. This was evident in cases such as those of Mozambique and Madagascar, which benefited significantly from pre-investment. The study underscores the importance of integrating preparedness into national planning, emphasizing that preparedness should be a multisectoral effort involving all areas of emergency planning and management. Ms Sen highlighted that clear cost-benefit analysis helps governments prioritize and strategically allocate budgets for emergency preparedness, making it a crucial aspect of national resilience strategies. She also emphasized the importance of regulatory bodies in emergency communication, within a broader framework of preparedness. She highlighted the role of national working groups, where regulators are crucial participants in emergency preparedness discussions, especially in small island states like Dominican Republic. Their tripartite engagement with disaster management and emergency authorities improved resilience, as evidenced during Hurricane Fiona. Ms Sen also noted that in many countries and regional blocks, regulatory involvement has been increasingly emphasized to ensure swift decision-making during evolving crises, underscoring the critical role of regulators in preparedness and response coordination. She reminded all that the previous year, ITU had collaborated with the Southern African Development Community to develop a model emergency telecommunications plan, benefiting countries prone to disasters and varied development situation countries in the region. Regulatory engagement was crucial in preparing this model and operationalizing its aspects. Similar efforts were undertaken in the Caribbean region, where ITU supported emergency telecommunication simulations to enhance disaster resilience, and test regulatory, policy, and procedural readiness. These initiatives highlighted the pivotal role of regulators in emergency response, underscoring their importance, despite initial involvement levels in decision-making processes. Ms Ria also highlighted significant challenges faced by landlocked developing countries (LLDCs) and small island developing states (SIDS), emphasizing their struggle against natural imbalances, and limited resources for disaster resilience. She stressed the complexities of decision-making involving investments in emergency telecommunications versus other urgent developmental needs such as food security or healthcare. Ms Ria shared proactive examples from their work, such as earthquake preparedness initiatives and cyclone simulation exercises, which demonstrated the importance of national coordination, and regional cooperation in enhancing disaster preparedness across diverse environments and developmental stages. She also discussed the role of the Emergency Telecommunications Cluster (ETC) as an emergency coordination mechanism, emphasizing proactive engagement in both crisis response, and preparedness. The Cluster collaborated closely with national ICT Working Groups, advising and supporting them in setting priorities and implementing emergency communication strategies. For instance, in Madagascar, the Cluster conducted capacity assessments, and recommended interventions to establish a robust national Working Group ahead of the annual cyclone season and other potential crises, highlighting the multifunctional nature of these efforts in responding to disasters such as cyclones, the COVID-19 pandemic, and famines. The approach involved tailored responses to specific national needs, deploying equipment and response coordinators to

²⁹² https://www.itu.int/dms_pub/itu-d/oth/07/31/D07310000050010PDFE.pdf

assist in early recovery, and reconstruction phases post-disaster, while maintaining close collaboration with national authorities for sustainable service provision.

Ms Kathryn Condello, from Lumen Technologies, emphasized the role of Lumen Technologies in minimizing disruptions and speeding up recovery in various crises such as hurricanes, fires, or cyberattacks. Working closely with operational teams, their focus was on advanced planning, derived from past events, to develop effective protocols and strategies. This proactive approach aimed to enhance resilience across all circumstances and situations, by anticipating challenges and implementing coordinated plans, programmes, and regulations. In challenging environments, whether in developing countries or difficult-to-reach areas, it is recognized that financial resources are always insufficient. Planning becomes crucial to acknowledge and work within the constraints, focusing on local or regional collaborations, to establish safety nets for communication. These efforts, though not ideal, foster innovative solutions tailored to specific risks such as hurricanes, emphasizing local engagement to build resilience and explore alternative communication methods such as satellite, or two-way radios when primary services falter. The goal is to create scalable solutions through community understanding and cross-regional support in crisis scenarios. Advanced planning is crucial as it allows for strategic investment in developing relationships, protocols, and processes without requiring substantial financial resources. Planning enhances resilience by refining investments in physical infrastructure and communication protocols, and fosters collaboration across local, regional, and national levels. This proactive approach aims to mitigate the impact and duration of threats, including in contested environments impacted by evolving cyber challenges.

During the Question-Answer part of the session, Internet Society (ISOC) thanked the panellists for their insights and posed two questions. The first question asked the panellists for examples of Internet service providers (ISPs) performing effectively during crises. The second question, concerning top infrastructure data points to assess network resilience, could the panellists select three ideal metrics they would wish to have publicly available. In response, Mr Justin Cain highlighted that ISPs are resilient in crises, despite facing challenges, as they dedicate resources to maintain communications. He emphasized the ongoing difficulty in identifying infrastructure choke points, underscoring the need for comprehensive risk assessments to understand interdependencies and bolster infrastructure resilience, and particularly critical infrastructure resilience. Mr Cain advocated for a collaborative approach involving communication companies, stakeholders, and agencies, to enhance redundancy planning and mitigate downstream impacts of disruptions. Regarding the top three infrastructure data points, Mr Cain emphasized the importance of understanding network architecture, core locations, and choke points to improve long-term preparedness and response strategies tailored to different disaster scenarios and vulnerable regions. His insights underscored the necessity for continual risk evaluation and community cooperation to strengthen infrastructure resilience in the face of crises.

Ms Kathryn Condello underscored the significant collaboration among ISPs during the COVID-19 pandemic, highlighting how they adapted to shifting traffic patterns globally. She emphasized proactive engagement of Lumen with fellow carriers, Internet exchange points, and content delivery networks to manage traffic flows effectively. This included balancing demands such as coordinating the release schedules of major video games and movies to optimize network performance. Ms Condello noted that this period offers a pivotal opportunity for unprecedented collaboration, extending beyond the usual partnerships like AT&T and BT, to collectively address global traffic challenges, and ensure uninterrupted service delivery worldwide. This would demonstrate enhanced resilience in a crisis scenario on a global scale. The representative from Côte d'Ivoire asked whether regional Working Groups should be established to discuss risk reduction in the case of disasters, considering that over 40 per cent of countries do not have emergency plans, as highlighted by the panellists. In response, Ms Condello emphasized the importance of evolving as a cluster to address region-specific hazards and vulnerabilities, highlighting the need for cooperation to develop model plans that can enhance preparedness.

Ms Sen acknowledged that while some regions have successfully developed model plans, there are challenges in certain subregional blocs where this may not be prioritized. She underscored the

role of Member States in advocating for these issues within subregional bodies, emphasizing that United Nations entities can only support such initiatives upon receiving national requests. Ms Ria stressed the importance of national engagement to bolster regional plans and encouraged countries to seek technical support and assistance from the United Nations Secretariat and the Emergency Telecommunications Cluster (ETC) for coordination and capacity development. The representative from Dominican Rep. emphasized the ongoing and evolving nature of climate change, stressing the need for constant improvement in protocols and preparedness efforts by leveraging new available technologies. They underscored the necessity of international agency support and collaboration between the private and public sectors to effectively address these challenges.

Ms Ria highlighted the close collaboration with the Dominican Rep. and underscored that climate change, with its increasing frequency and severity of hazards, emphasizes the critical need for effective emergency telecommunications coordination mechanisms. She emphasized the pivotal role of regulators, disaster management authorities, and ICT agencies in driving interventions to enhance resilience. Ms Ria acknowledged that while coordination is crucial, there is still significant work needed in capacity development and supporting vulnerable communities. She viewed these efforts as a positive starting point toward improving overall resilience.

SESSION 2 – Technological innovation and cooperation: Information and communication technologies as key tools in emergency management and post-disaster reconstruction

Session 2 began with introductory remarks by the moderator, Mr Serigne Abdou Lahatt SYLLA (Senegal), co-rapporteur for ITU-D Question 3/1.

Professor Cheikh Ahmadou Bamba Gueye, University Cheikh Anta Diop from Senegal presented a study²⁹³ on unconnected areas during the session. He defined "white spot areas" as regions lacking cellular network coverage, which exacerbates vulnerabilities during disasters when infrastructure is destroyed. Prof. Gueye introduced the COWSHED project, which employs long-range communication technology to cover distances of up to 15 kilometres in interconnected areas. Highlighting that 70 per cent of the population in developing countries like Senegal remains unconnected, mostly in rural areas with low incomes. He emphasized how limited operator investment exacerbates the prevalence of white spot areas, hindering both basic communication and Internet access. Gueye proposed utilizing open frequency bands for meshed networks to enhance connectivity in pastoral regions, which is crucial for herders navigating climate change impacts including diminishing grazing areas, and water sources, and enables them to share vital information efficiently. He continued his presentation by illustrating the evolution of 2G coverage in Senegal from 2017 to 2021, highlighting persistent white spot areas where no cellular network exists. He emphasized the significance of these white spots in regions such as the Sahel, and how they are impacting livestock herders' ability to sell livestock, and fishermen's access to communication while at sea. The COWSHED project utilizes low-cost solutions such as LoRa technology which operates efficiently over distances of 15 to 25 kilometres without high energy consumption. He explained how this technology facilitates communication between livestock herders, and mitigates conflicts over grazing areas, utilizing gateways and smartphones to extend network reach within the community. Prof. Gueye emphasized ongoing research to enhance the COWSHED technology to better support rural communities in Senegal and other developing regions. He then proceeded to present the results of tests conducted in the Ferlo region, where infrastructure is absent, demonstrating the capability of their system to cover distances up of to 15 kilometres effectively. He then showcased the setup of the gateway mobile unit, which livestock herders can carry in a backpack along with a solar panel to ensure continuous power supply. This setup allows herders to remain independent as they move across fields, ensuring the device remains charged throughout their journey. Prof. Gueye emphasized the performance of the system in various environments, including at sea, where it can cover up to a 25-kilometres radius, due to better wave propagation over water compared to land. He highlighted the use of digital terrain models (DTMs) to extend network coverage, enabling nodes within the 15-kilometre radius to relay information, and discussed ongoing research

²⁹³ https://www.itu.int/dms_pub/itu-d/oth/07/31/D07310000050008PDFE.pdf

using satellite technology for uplink connections to enhance communication capabilities in remote areas.

Professor Chen Tao, Tsinghua University²⁹⁴; highlighted several major disasters and their impacts. The presentation underscored challenges during mass casualty incidents (MCI), such as insufficient resources, transportation limitations, and the critical importance of timely treatment within the "golden hour." It is very difficult to implement fast and accurate on-site triage with the current processes and technology. The speaker advocated for improved triage processes using AI and machine learning (ML) to enhance accuracy and speed in assessing injuries and prioritizing treatment. The need to focus primarily on patients who need immediate treatment was acknowledged, and technology is expected to have a significant effect by collecting and analysing face video data, voice data and physiological data. They concluded with a proposal for a comprehensive emergency medical system integrating advanced technologies such as AI, mobile field hospitals, and coordinated command systems, to optimize disaster response and minimize casualties and disabilities.

Ms Naomi Ng'ang'a from Kenya Red Cross; presented²⁹⁵ a comprehensive approach to disaster management, focusing on leveraging technology to prevent and alleviate human suffering across the country. Ms Ng'ang'a highlighted the use of Mapathons to map high-risk areas such as flood zones and critical infrastructures such as schools and hospitals, enabling evidence-based decision-making, and efficient resource allocation during disasters. Capacity-building trainings for local government personnel in mobile data collection and management, were pivotal in enhancing local resilience efforts. Satellite imagery and drone technology played crucial roles in disaster assessment and response, from prepositioning resources based on flood impacts, to monitoring locust infestations. The development of a focused-based financing EWS underscored their commitment to proactive disaster preparedness, aiming to reduce impacts and optimize response strategies. Continuous community feedback and capacity building were emphasized as essential components in ensuring the effectiveness and sustainability of digital transformation initiatives.

Ms Monique Kuglitsch from Fraunhofer HHI, Germany; spoke about the global initiative that emerged from the Focus Group on AI For Natural Disaster Management, aiming to advance standards in this critical field. Hosted within the ITU Telecommunication Standardization Sector, the initiative focuses on establishing guidelines for AI applications in disaster management, addressing gaps identified in existing international standards. Over three years, the initiative engaged experts globally through 12 topic groups, developing 27 use cases to illustrate the role of AI across various natural hazards. Key outputs include reports on data management, AI modelling, and operational integration, emphasizing transparency, ethical considerations, and user-centric design. Educational initiatives, hackathons, and workshops have facilitated widespread capacity-building efforts, fostering collaboration among stakeholders to enhance disaster resilience worldwide. Concluding its three-year term, there is strong interest from participants and United Nations partners to extend the efforts of the initiative. A recent meeting co-hosted by NASA and the University of Maryland, Baltimore County marked this transition, attended by representatives from key United Nations agencies. The initiative aims to build on past achievements, expand use cases, and integrate emerging technologies such as digital twins. The initiative plans to update technical reports, delve into new topics, and prioritize implementation to ensure proposed best practices are effectively applied. The first major project of the initiative, a three-year effort funded by the European Commission Horizon programme, focuses on developing a multi-hazard EWS across the Mediterranean region to Sweden, testing AI and related technologies for decision support, forecasting, risk assessment, and community outreach. For access to documents and involvement in upcoming activities, visit the initiative website via the provided QR code.

During the Question-Answer part of the session; the moderator posed a question to Ms. Naomie Ng'ang'a focused on the importance of cooperation among governments, humanitarian centres, private companies, and civil populations in disaster preparedness and relief efforts. The question

²⁹⁴ https://www.itu.int/dms_pub/itu-d/oth/07/31/D07310000050014PDFE.pdf

²⁹⁵ https://www.itu.int/dms_pub/itu-d/oth/07/31/D07310000050011PDFE.pdf

also touched on the challenges related to illegal migration and its impact on safety, poverty, and community resilience. Ms. Ng'ang'a highlighted advancements in preparedness through collaborative efforts, emphasizing the need to leverage strengths of different stakeholders, including private sectors, for information and cash transfers. She underscored the importance of building community resilience proactively, rather than solely focusing on response, and of integrating local knowledge with scientific information, to effectively address disaster risks and community needs. Ms Monique Kuglitsch emphasized several approaches to engage with countries in the context of standardization activities related to AI. She highlighted the importance of considering regional differences, capabilities, feasibility of AI use, data availability, and infrastructure when developing standards. Insights are gathered from ITU Member States' engagements, and from ongoing research studies such as those in Mozambique and Ethiopia, which provide valuable regional perspectives. Collaboration with organizations such as the African Union, and engagement with small island developing states (SIDS) in the Caribbean region further enrich the standardization process. Ms Kuglitsch encouraged further engagement and sharing of experiences to enhance their focus group activities.

By presenting innovative applications and platforms using ICTs for real-time data collection, mapping of disaster areas, and coordination of relief efforts, the speakers demonstrated the importance of coordination for more successful actions and interventions during disasters. To achieve this, it was recommended that a community of committed stakeholders and experts be created, building on the progress already made by the ITU in this area. In essence, the session examined the critical role of ICTs in emergency management and post-disaster reconstruction, and highlighted technological innovations, and best practices in the use of ICTs to respond effectively to crises and facilitate the sustainable reconstruction of disaster-affected populations. The necessity for collaboration and coordination between governments, humanitarian organizations, the private sector, and civil society in the use of ICTs for disaster prevention, emergency response, and reconstruction was emphasised, as was the importance of continuing to introduce innovative technologies such as artificial intelligence, the Internet of Things (IoT), and megadata analysis into disaster management.

Conclusions of the Workshop

Ms Alison Balzer (United States), Co-Rapporteur for ITU-D Question 3/1, expressed her delight at the experiences shared. She then reiterated her thanks to the speakers, participants and BDT team.

A4.3 Transformative connectivity: Satellite workshop²⁹⁶

The joint Q1/1, Q3/1, and Q5/1 workshop informed administrations of the unprecedented innovation in the satellite industry in terms of coverage, capacity, and integration with terrestrial technologies. The workshop focused on how developing countries, particularly unserved or underserved, and rural and remote areas, can benefit from these developments. The goal was to support administrations in building their national digital strategies to advance the connectivity goals of each country by identifying challenges, and potential collaborations to achieve meaningful connectivity with the objectives of providing connectivity to all, and providing regulatory and business best practices. The workshop, structured into four sessions, brought together stakeholders from ITU, various industries, and administrations to discuss the current state of the satellite industry, its impact on developing countries, its role in disaster response, and its potential for future convergence with traditional network infrastructure.

The third session "Satellites to support disaster mitigation, preparedness, response and recovery" was on the following items:

²⁹⁶ For further information, see the workshop [webpage](#) and workshop report document [1/346-E](#).

- Satellite applications for disaster prediction, detection, monitoring, early warning, response, relief, and recovery – EW4ALL (Early Warning for All).
- Ensuring a favourable regulatory environment to enable rapid deployment and implementation of satellite technologies in support of disaster mitigation, preparedness, response, and recovery.
- Public/private partnerships for disaster preparedness and recovery.
- Building an enabling environment for resilient networks including satellite, for emergency communication systems.

The third session shifted to the critical role of satellites in strengthening disaster resilience. Speakers emphasized the irreplaceable nature of satellite communication during emergencies when traditional infrastructure may be damaged or overwhelmed. The session also discussed the 'Early Warnings for All' initiative, highlighting the importance of collaboration in disaster preparedness efforts.

In conclusion, the workshop underscored the growing significance of satellites in bridging the digital divide, especially in remote areas, and also other areas such as the use of satellites and Wi-Fi as complementary technologies for Wi-Fi connectivity in-flight. The workshop has also focused on the implementation of satellite technologies in support of disaster mitigation, preparedness, response, and recovery. Collaboration between stakeholders, effective spectrum management, and user-centric approaches are crucial for success. The promising potential of non-terrestrial networks (NTNs) suggests a future where satellite and terrestrial networks work together as complementary technologies to create a more connected world. The workshop outcomes were summarized in the interim report.

Detail report of session 3 of the joint workshop

Session 3 – "Satellites to support disaster mitigation, preparedness, response, and recovery"

Session 3 began with opening remarks from Mr. Gokhan Tok, Access Partnership Ltd, vice-rapporteur for ITU-D Question 3/1. This session focused on how satellite communication strengthens disaster resilience. It highlighted the importance of this technology when other communication fails during disasters.

Ms. Maritza Delgado, Programme Officer, EET Division, BDT, ITU⁷ elaborated on the Early Warnings For All initiative. This initiative launched by United Nations Secretary-General in 2022, with the ambitious goal of ensuring that every person on Earth is covered by an EWS by 2027. The key highlights of this initiative centred around the four pillars of the initiative: (1) Disaster Risk Knowledge (UNDRR): Educating communities about hazards and risks, (2) Observation and Forecasting (WMO): Collecting, analysing, and predicting hazards, (3) Warning Dissemination (ITU): Using technology to deliver early warnings, and (4) Preparedness and Response (Red Cross): Helping communities understand warnings and take action. Representatives from Türkiye, India, and multiple organizations sought further information on the implementation of the Early Warnings for All initiative. This United Nations-led effort aims to provide everyone with EWSs for disasters by 2027. Technology is crucial, with satellites seen as a good option for reaching remote areas. ITU, which is a United Nations agency, works with governments, telecommunications companies, and at-risk communities to establish warning systems. This includes creating regulations, training exercises, and emergency plans. India suggested using mobile Internet for alerts, but the Speaker recommended a multi-channel approach considering factors such as a country's infrastructure and population.

Mr. Tare Brisibe, Senior Legal & Regulatory Counsel, APAC, SES⁸, talked about the SES Humanitarian Solutions initiative, referring to SES which is a global satellite operator offering communication solutions. The Speaker focused on how SES supports disaster relief and recovery. SES offers rapid response solutions using existing satellite infrastructure, such as geostationary (GEO) and medium Earth orbit (MEO) satellite constellations, for immediate communication needs following disasters, such as was

the case following the Tonga volcanic eruption. During disaster recovery, SES provides solutions for scaling communication capacity, as was the case post-Tonga eruption and post Hurricane Ian. This can even transition into long-term network resiliency (Tonga). SES is part of 'Emergency.LU,' a public-private partnership offering free, mobile satellite communication to first responders during disasters. Emergency.LU has completed dozens of missions globally in the past year. The Speaker highlighted the importance of spectrum availability for disaster response, existing satellite infrastructure vs. deploying new equipment after disasters, interoperability between satellite operators for broader communication access, and integrating satellite connectivity into existing broadband networks. The Speaker recommended for the development of a coordinated plan for disaster response, involving all stakeholders (businesses, institutions, local operators). This facilitates resource pooling and improves response efficiency. In response to the enquiries about the challenges a satellite operator faces when providing connectivity in a new disaster zone, SES highlighted several challenges including difficulties in importing terminals and ground stations, and difficulties in obtaining spectrum access. He also noted that a surge in communication needs after a disaster can strain satellite network capacity, damaged infrastructure can hinder equipment movement to affected areas, satellite infrastructure might rely on other (potentially damaged) infrastructure for functionality, disasters often cause power outages, requiring alternative power solutions such as solar or generators for terminals, that high winds, floods, etc. can make installing terminals difficult, and that security issues, and other unforeseen issues might arise after the initial crisis.

Ms. Donna Bethea-Murphy Policy Spectrum, Senior Vice President Global Regulatory and Technology Policy, Viasat⁹ talked about the Satellites in Disaster Relief initiative. The Speaker highlighted the importance of satellites in disaster preparedness, warning, and response. The Speaker focused on the crucial role of satellites in the first 48 hours after a disaster. Prepositioning satellite equipment and training for usage is crucial for preparedness. Public awareness campaigns are needed to encourage proactive disaster planning. Viasat advocates for integrating satellite redundancy into existing communication infrastructure. All types of satellites (meteorological, GPS, mobile, and broadcasting satellites) play a role in disaster management. EWSs such as dam monitoring devices, and tsunameters utilise satellites for communication. The Speaker shared some examples, in which satellite phones were used to coordinate aid deliveries after a hurricane destroyed airplane runways on an island. Portable telemedicine equipment allows first responders to consult with medical professionals via satellite. The representative from United States raised the issue of preparedness for network congestion during disasters, focusing on policies, agreements, and relationships. The Speaker highlighted two key areas for preparedness. The first area for improving preparedness is the use of 'Continuing Operation Plans (COPs)' whereby regulators need a COP to quickly grant access to alternative communication providers (e.g., satellite companies) during disasters. Here the COP plan should define clear communication channels – who to contact and how, even if displaced. The United State example demonstrates the importance of practicing these plans. The second area for improving preparedness is 'User Preparedness', whereby users should be familiar with backup communication methods (e.g., VHF radios) to avoid confusion when primary networks are congested. Viasat suggests exploring direct-to-device (D2D) satellite communication, potentially built into mobile phones, as an emerging solution for disaster situations. This technology is still under development but could be a future policy consideration.

Mr. Veli Yanıkgönül, Director Spectrum Management, Turksat¹⁰ presented on the role of Turksat in disaster management. The Speaker emphasised the importance of satellite communication in disaster preparedness, response, and recovery. The Speaker focused on the experience of Turksat, a Turkish satellite communication company. Turksat collaborates with the Government of Türkiye agencies (AFAD, Red Crescent) to build infrastructure for disaster preparedness. This includes central/mobile coordination centres, data transfer vehicles, and staff training. Turksat prioritises providing uninterrupted communication during disasters. They offer services such as connectivity for government agencies, shelters, and public announcements and backhaul capacity for terrestrial mobile operators whose infrastructure is damaged. The Speaker recommended that the regulatory efforts focus on the national and international regulations for disaster response, as well as sufficient, globally harmonised satellite spectrum, protection of satellite spectrum from harmful interference,

national frequency allocations that prioritise disaster response needs, and streamlined licensing and authorisation procedures for satellite operators. The Turksat response to a recent major earthquake in Türkiye affecting 11 cities, faced challenges in providing a huge amount of data capacity, over an extensive area, within the first 48 hours following the disaster. Turksat provided connectivity for government agencies, shelters, public announcements, as well as backhaul for mobile operators. Effective disaster management requires coordinated efforts across various stakeholders, including regulatory bodies, and satellite operators. In response to the concern raised on the biggest challenges they faced (technological, logistical, or regulatory) in their past disaster response experience, the Speaker emphasised that all three aspects (regulatory, technical, logistical) are crucial for effective disaster response. They need to work together to ensure a healthy satellite industry that can handle emergencies, to have sufficient satellite capacity available in the affected country, and to respond quickly and reach all affected areas.

Ms. Astrid Bonté, Director of International and Institutional Affairs, Eutelsat Group, presented on 'Satellite communication for disaster recovery, and how satellite communication can improve disaster response'. Satellite communication is crucial for EWS and for resilient communication networks in disaster situations. Eutelsat Group has extensive experience providing connectivity during disasters such as hurricanes, earthquakes, and fires. They offer high-throughput, easily deployable antennas and user terminals, along with solar energy kits for independent operation. Eutelsat provides a unique combination of geostationary (GEO) and low Earth orbit (LEO) services, offering high capacity, global coverage, and low latency. Eutelsat works with organizations including Telecom Without Frontiers, and the United Nations Crisis Connectivity Charter to equip responders and governments with satellite connectivity during disasters. Regulatory hurdles, such as import licences and customs restrictions, often delay deployment of satellite services. The Speaker recommended for the development of pre-approved temporary licence templates for disaster-prone regions to expedite service activation, the conducting of training sessions for disaster responders on using satellite equipment and services, and for the creation of a central map of pre-identified resources and solutions for faster disaster response. The Speaker emphasised the critical role of satellite communication in disaster recovery, and proposed solutions to overcome current obstacles for faster and more effective response.

In conclusion for session 3, the Chairperson highlighted key takeaways from the session in terms of challenges in which familiar issues persist, such as power outages, equipment importation difficulties, and lack of trained personnel after disasters. New technological solutions such as multi-orbit satellites, and advanced device technology offer promise. Pre-disaster coordination with response authorities and NGOs is crucial, and supportive regulations and streamlined import processes are essential. The session concludes with a call for a harmonised global spectrum for disaster response communication, including lite licensing and import regimes. These discussions will continue to be a focus area for future sessions.

Annex 5 – Bibliography

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|-----------------------|--|
| [b-Q5/2 final report] | ITU-D Question 5/2: Utilizing telecommunications/ICTs for disaster risk reduction and management, 2018-2021 study period: https://www.itu.int/hub/publication/d-stg-sg02-05-2-2021/ |
| [b-NETP] | ITU Guidelines for national emergency telecommunication plans: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Publications/Guidelines-for-NETPs.aspx |
| [b-ITU-T X.1303] | ITU-T Recommendations X.1303: Common alerting protocol (CAP 1.1) https://www.itu.int/rec/T-REC-X.1303-200709-I |

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