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Beyond The Nuclear Explosion Verification Monitoring, the Comprehensive Nuclear-Test-Ban Treaty Offers A Strong Capacity Building System Support

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Abstract

Purpose: The United Nations (UN) General Assembly, as part of nuclear non-proliferation and disarmament measures to prohibit nuclear test explosions and any other nuclear explosions in all environments (in the atmosphere, oceans, and underground) adopted the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Thus, it ultimately enhances international peace and security. It is an essential step aimed at making the world a safer place. States that agree to sign on to this Treaty will be contributing to the protection of human health and the environment against nuclear test explosions and their severe impacts. This paper seeks to demonstrate that the CTBT beyond its global prohibition measure against all nuclear explosions, is offering a strong Capacity Building System support to State Signatories such as the Republic of Ghana. The CTBT global verification regime is built to monitor States Signatories compliance with the Treaty. CTBT Organization (O) through the International Data Centre (IDC) provides States Signatories with technical assistance to support their verification responsibilities to ensure effective global monitoring.

Methodology: The Republic of Ghana through the Capacity Building project under the IDC technical assistance to States Signatories is a beneficiary of equipment support commissioned in July 2021. Under this project the GCI-III/VSAT equipment set was received from the IDC, establishing a new communication link for forwarding IMS waveform data from some selected stations in Africa in near-real-time to the National Data Centre – Ghana (NDC – GH). The IMS seismic data also contributes to prompt access to information on seismic events within our respective geographic territories globally, thus playing a complementary role.

Findings: The monitoring data generated provides essential civil and scientific applications to greatly support to mitigate the effects of natural or man-made disasters. This is an example of what the CTBT is providing to Member States beyond the Treaty's main purpose.

Unique contributor to theory, policy and practice: It is therefore important for the international community to fashion out other multilateral agreements considering the possibility of incorporating the potential additional benefits States can derived from such agreements.

Keywords: *CTBT, Nuclear Explosion, Capacity Building System, GCI-III/VSAT, States Signatories, Republic of Ghana*

Introduction

In response to the growing concerns about the proliferation of arms/weapons of mass destruction especially with nuclear weapons decades ago, the global community under the auspices of the United Nations established the multilateral treaty known as the Comprehensive Nuclear-Test-Ban Treaty (CTBT) [1].

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) prohibits nuclear test explosions and any other nuclear explosions in all environments (in the atmosphere, oceans, and underground) [1, 2, 3]. This Treaty was opened for signature by Member States under the United Nations General Assembly (UNGA) on 24 September 1996 [1, 4, 5]. The CTBT is a measure for arms control against nuclear proliferation and disarmament [3]. Thus, with the ultimate objective of enhancing international peace and security [1, 6]. Since it bans any kind of nuclear explosions, it is an essential step aimed at making the world a safer place [6, 7]. By agreeing to be part of this Treaty, State Signatories will be contributing to the protection of human health and the environment against the serious impacts of nuclear test explosions [7, 8]. The Republic of Ghana signed the Treaty on 3 October 1996 and ratified it on 14 June 2011, hence part of the CTBT [9].

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is established to see to the operationalisation of the Treaty's goals. It is located in Vienna, Austria. The CTBTO was set up to prepare for the entry into force (EIF) of the Treaty [2]. One of the main tasks of the CTBTO is to establish a global verification regime capable of detecting nuclear explosions underground, underwater, and in the atmosphere to build confidence among nations [2]. The CTBT global verification regime is built to monitor States Signatories compliance with the Treaty [7]. Member States therefore have access to monitoring data to enable them to assess whether or not a particular suspicious event that has occurred amounts to a violation of the Treaty. It is vital to note that after the adoption of the CTBT in 1996, even though it has not yet entered into force, it is already helping to create a de facto international norm against nuclear testing [7], with just ten tests carried out since then, while recalling the over 2000 nuclear test prior to [7].

As part of its task, the International Data Centre (IDC) of the CTBTO provides technical assistance to States Signatories to support their verification responsibilities to ensure effective global monitoring [10]. Thus, enabling Member States to receive, process, and analyse the data and products on their own [11].

Such technical assistance to States Signatories is provided through the Capacity Building project [12]. It is under this project that the Republic of Ghana has been a beneficiary of a Capacity Building System (CBS) equipment support in 2021. This paper therefore seeks to demonstrate that the CTBT beyond its global prohibition measure against all nuclear explosions, is offering a strong Capacity Building System support to State Signatories such as the Republic of Ghana.

Purpose of CTBT and the Verification Regime

The CTBT was established with the sole purpose "of attracting the adherence of all States to this Treaty and its objectives to contribute effectively to the prevention of the proliferation of nuclear weapons in all its aspects, to the process of nuclear disarmament and therefore to the enhancement of international peace and security" [1]. With this noble goal in mind, Member States are therefore urged to sign onto the treaty to contribute to complying with the global ban on all nuclear explosions of any kind, thereby preserving human lives and the environment from the harmful effects of their occurrence.

The CTBT offers a unique verification regime that monitor nuclear explosions around the globe. There are three main elements/pillars of the treaty's verification regime, which includes the International Monitoring System (IMS), International Data Centre (IDC) and On-Site Inspection (OSI) [13]. The IMS provides a planned network of 337 monitoring facilities dotted around the world [14]. These monitoring stations use seismic, hydoacoustic, infrasound and radionuclide technologies to monitor nuclear explosions. IDC receives real-time monitoring data from the IMS stations. Also, process and analyze the data into data bulletins which are made available to Signatory States in addition to the raw data [15]. While OSI provides in-the-field opportunity to do observational measurements at a suspected explosion site [13]. This can only be invoked after entry into force of the Treaty [13].

Capacity Building System Support

CTBTO offers services and technical assistance to States Signatories in order to provide them with requisite support to effectively participate in the global verification monitoring [12]. By so doing, assist in fulfilling the verification responsibilities of States Signatories under the Treaty. This is achieved through the Capacity Building project under the International Data Centre (IDC) of the CTBTO. Through this Capacity Building project, the CTBTO Preparatory Commission engages States Signatories to integrate them to fully participate and contribute to the implementation of CTBT monitoring and verification [2]. The National Data Centre – Ghana was established and commissioned on the 3rd February 2010 [11] to serve as a technical liaison between CTBTO and the national authority of the State Signatory.

The Capacity Building project is aimed at providing States Signatories with sufficient knowledge and assistance for building their National Data Centres (NDCs) and/or improving their capabilities [2, 16].

Using a five-step strategy, the IDC offers technical assistance to States Signatory through the implementation of a Capacity Building project as follows: Development of country profiles for all States Signatories; Provision of a regional NDC development workshop; Provision of various training courses for NDC technical staff; Provision of basic NDC equipment; and Provision of experts for follow-up visit to NDC [2].

The NDCs of States Signatories mainly from developing countries are therefore provided with Capacity Building System (CBS) equipment through this programme to aid the establishment and further development of national capacity to participate actively in the verification regime by accessing and analyzing IMS data and IDC products [2]. The CBS project receives its funding from the Regular Budget of the CTBTO in addition to voluntary contributions from the European Union. Since 2009 that the CBS projected started, the CTBTO continue to implement the programme and as such provides equipment to NDCs of States Signatories based on requests [2]. In 2010, a CBS mainframe sever support was offered to NDC – GH from the CTBTO as part of its establishment programme [11].

Through this equipment support, States Signatories such as Republic of Ghana are able to receive IMS data and IDC products from the IDC to facilitate their verification responsibilities for effective global monitoring in addition to the civil and scientific benefits [2]. Additionally, training programmes organized under the project are designed to build capacities in various verification-related disciplines [2].

IMS and Monitoring Data

One of the core elements of the verification regime is the IMS, which is set up to monitor the violation of the Treaty's ban on nuclear explosions [1, 2].

The IMS comprises networks of stations and radionuclide laboratories of 337 facilities to be established and operated in 89 host States worldwide when completed [17, 18]. The IMS facilities include the following technologies (50 primary seismic stations, 120 auxiliary seismic stations, 80 radionuclide stations (40 with noble gas monitoring capability), 11 hydroacoustic stations, and 60 infrasound stations) [3, 4, 17]. Additionally, to support the radionuclide monitoring stations network, 16 radionuclide laboratories would be used to conduct re-analysis of samples from the stations to confirm or clarify anomalous detections [3]. It is essential to know that of the four monitoring technologies, radionuclide monitoring is the only technology that provides the confirmatory evidence that a detected explosion is nuclear or not [3, 20]. These facilities are located worldwide, with their location determined to maximize global coverage without focusing on any particular countries [17]. As part of the arrangement for States hosting the IMS facilities, ownership and operation of the monitoring station shall be with the States Parties hosting them or otherwise under their responsibility per the CTBT Protocol; although, they remain under the authority of the Technical Secretariat, as provided in Article IV of the Treaty [1, 18]. Once a new monitoring facility is built, it is tested to meet all the requisite technical specifications to pass the certification process [3]. It is then certified and added to the IMS stations network [3]. The seismic, hydroacoustic, and infrasound (SHI) stations generate waveforms that send continuous near-real-time data, whereas radionuclide (RN) stations generate spectra that send segmented data to the IDC, in Vienna through the Global Communications Infrastructure (GCI) link [18].

The status of the IMS stations network (Fig. 1 shows the complete IMS network) certified for operation as of 30 September 2023 is as follows;

- forty five (45) primary seismic and 109 auxiliary seismic stations; 11 hydroacoustic stations; 53 infrasound stations; and radionuclide stations that comprise particulate stations have 73 and 25 noble gas stations [19]. Also, 14 of 16 radionuclide laboratories are certified [19].

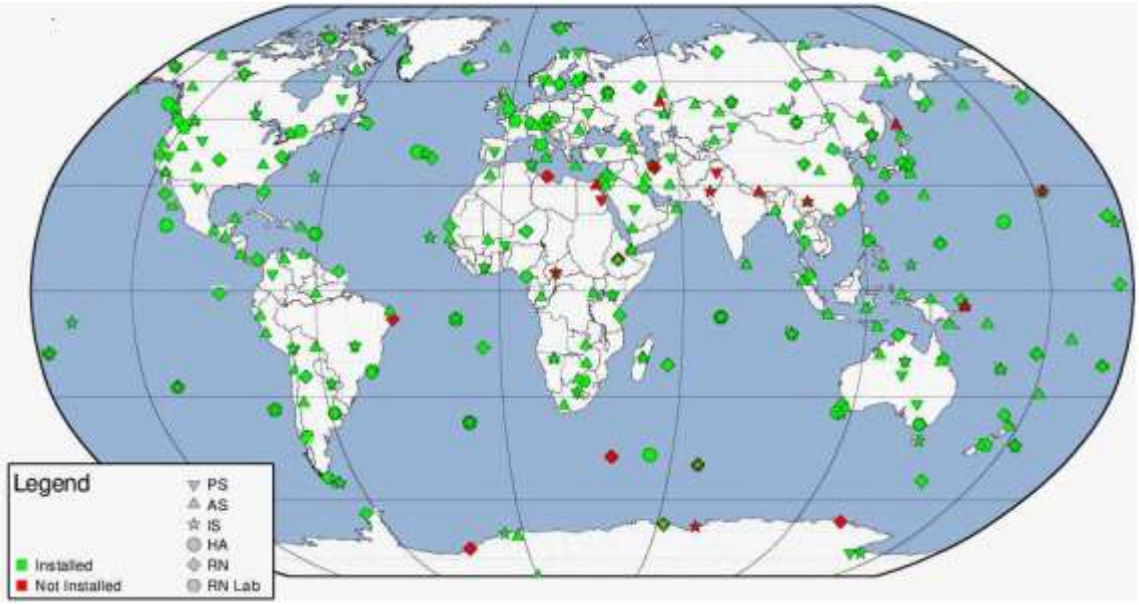

Fig. 1 The complete IMS facilities. It shows the Primary Seismic (PS), Auxiliary Seismic (AS), Infrasound (IS), Hydroacoustic (HA), Radionuclide (RN), and Radionuclide Laboratory (RN LAB) facilities, 2023 updated (figure adapted from [3]), [19].

GCI-III / VSAT Support for Republic of Ghana

Acknowledging the fact that confidence in a given treaty is the desired goal during its negotiations, such that the cause and driving force behind the development of elaborate formal mechanisms for monitoring and verification is technology [12]. The CTBTO operates a Global Communication Infrastructure (GCI) which consists of 215 VSAT connections and 6 terrestrial connections [3]. As part of the operations, the GCI link availability requirement is 99 %, which is reported as being currently achieved routinely [3].

Under the verification regime, it is the Global Communication Infrastructure (GCI) that is used to send data from the IMS stations to the IDC. Also, GCI is used to send IMS data and IDC products from the IDC to authorized users at the States Signatories [3].

As part of the process of capacity building to support NDCs to be well established and further their development to play their role effectively towards verification monitoring. The Republic of Ghana upon request to the IDC of the CTBTO received the equipment set, the third generation of the

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Global Communications Infrastructure (GCI-III) / Very Small Aperture Terminal (VSAT) from the IDC for the verification regime. Figure 2 gives the historical background activities that were undertaken prior to the GCI-III/VSAT installation and operation.

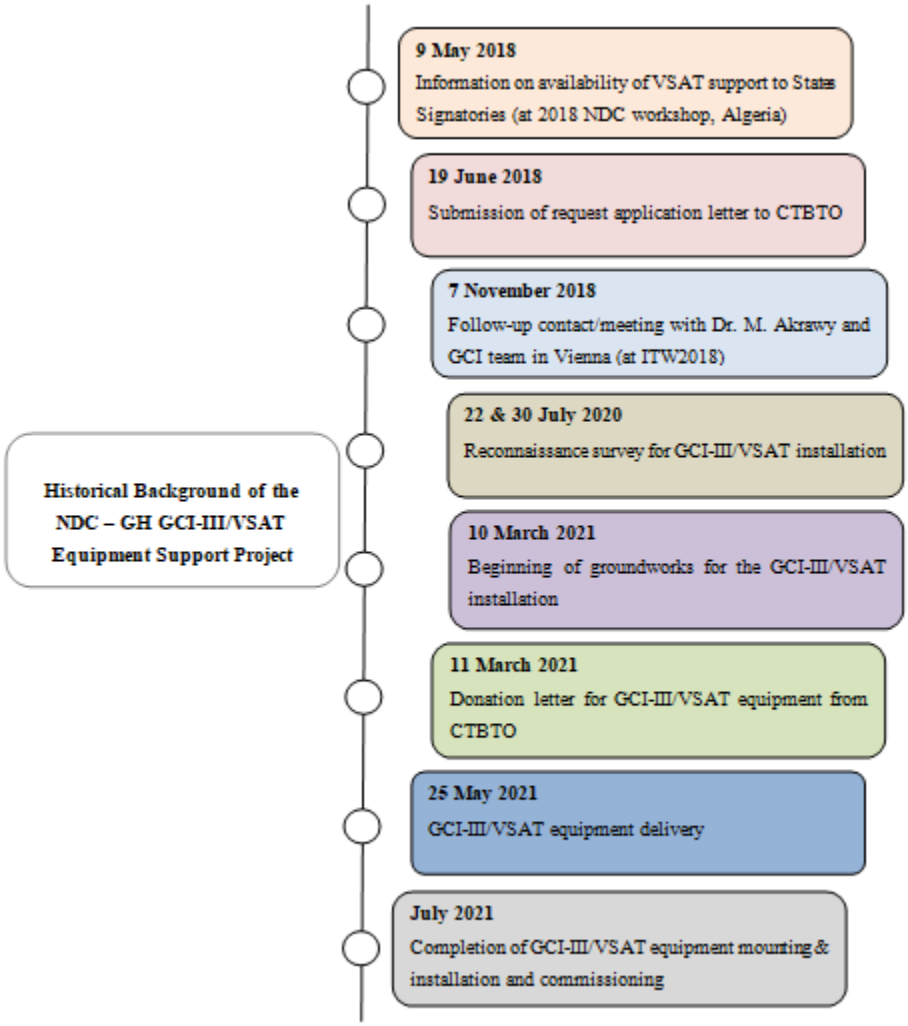

Fig. 2 shows the chronology of activities undertaken prior to GCI-III/VSAT installation and operationalization.

The CTBTO through the Hughes Network System, LLC (HNS), United States of America (U.S.A.) carried out the supply and delivery, installation and commissioning of the GCI-III/VSAT equipment for operation and maintenance. It was successfully installed and commissioned for operation in July 2021 at the National Data Centre - Ghana (NDC - GH). Figures 3 and 4 show the ground/concrete works for the VSAT installation as well as the GCI-III/VSAT equipment installed for operation. This newly established VSAT link is an essential element for the monitoring data to

be forwarded to NDC – GH upon request, considering its verification responsibilities as a State Party for contributing towards effective global monitoring and compliance of the Treaty. As such, the NDC – GH based on request, receives IMS data in near-real time through this newly established VSAT link to the IDC. The Republic of Ghana is, therefore, a beneficiary of the equipment support programme under this capacity building project.

Fig. 3 Ground/concrete works for the VSAT installation

Fig. 4 Installed GCI-III/VSAT equipment

Beyond the Nuclear Explosion Monitoring

The Treaty's verification regime is uniquely designed to monitor any nuclear explosion carried out anywhere (underground, underwater, or in the atmosphere) around the world as its core mandate

[21]. The system is designed to provide monitoring capability as equally as technically possible around the globe to ensure compliance with the treaty [22]. While playing this primary function, it's additionally providing valuable data for civil and scientific applications, which includes tsunami warning to save lives, tracking potentially harmful fallout from a nuclear accident, study of the Earth's structure and the natural world, climate change studies, among others [13, 23]. Also, all States Signatories are entitled to equal access to data and to benefit from technical assistance through training and capacity building programmes [23].

To maintain advances in scientific methods and technologies, the CTBTO continuously enhances its technical capabilities and keeps abreast with developments in science and technology [7]. This is done in preparedness for the Treaty's entry into force to ensure the readiness of the verification system to maintain the highest level of performance in fulfillment of its mandate [7]. It is essential to acknowledge that while the CTBTO works on the verification system to accomplish its core purpose of establishment, it is offering States Signatories the added opportunities to access the scientific and technological advances relevant to the system.

This is demonstrated in the technical support programme by the CTBTO through the GCI-III / VSAT equipment support received under the CBS project provided to the Republic of Ghana in July 2021 as a beneficiary.

This GCI-III/VSAT equipment received, is an essential element in the capacity building process, enabling the forwarding of monitoring data to NDC – GH. Through this newly established VSAT link to the IDC, the NDC – GH upon request receives IMS data in near-real time from the global monitoring network. Such supports to States Signatories play a vital role in the capacity building process. Thus, providing States with the opportunity to receive monitoring data of civil and scientific significance for humanity's benefit. Also complements the national technical means of monitoring seismological activities within their territories as well as other events under the remaining monitoring technologies. Thus, demonstrating a strong Capacity Building System support to States Signatories like the Republic of Ghana, beyond the treaty's primary purpose of banning and monitoring all nuclear explosions.

Non-Treaty Relevant Benefits of the Monitoring Data

Besides the CTBT's significance to arms control and global security, the additional benefits that accrue to States upon signing on are value-added advantages of non-treaty relevant applications of the monitoring data [25].

Acknowledging the primary purpose of the IMS network, which aims at monitoring and verifying compliance with Article 1 of the CTBT, thus banning all nuclear explosions everywhere (in the atmosphere, underground, and underwater) by everyone [1, 2]. Additionally, the Treaty provides essential civil and scientific applications of the monitoring data generated for the benefit of society [7, 8, 24]. These applications largely support the mitigation of the effects of natural or man-made

disasters, thereby contributing immensely and diversely to human safety and welfare [7]. It offers the opportunity to advance our wealth of knowledge about the planet [7]. Also, the data generated can assist in improving the quality of life as well as protecting our environment [7, 8].

For the seismological stations network, States Signatories that either lack their network or serve as a complement to theirs, access prompt information on seismic activity within their respective country or region. The data therefore provides the information to assess geophysical hazards and risk to assist in determining safe locations for vital infrastructure and installations [25].

In terms of the radionuclide stations network, aside from detecting the radioactive emissions from nuclear explosions, States Signatories can access and monitor the detection of other radioactive sources in their environment [25].

The infrasound stations network offers monitoring data essential to understanding the movements of weather fronts, volcanic eruptions, and shear conditions, with the resultant atmospheric turbulence. Thus, providing States Signatories with this important data is necessary for early warning of populations and the civil aviation industry [25**]**.

The hydroacoustic stations network may provide important evidence on the possibility of global warming, contribute data to assist in issuing tsunami warning alerts, and could also assist in locating submarine accidents, among others [25, 26, 27].

Conclusion

From the preamble to the CTBT, United Nations Member States "welcome the international agreements and other positive measures of recent years in the field of nuclear disarmament, including reductions in arsenals of nuclear weapons, as well as in the field of the prevention of nuclear proliferation in all its aspects" [1]. As one of the highest priority objectives to the International community in the field of disarmament and non-proliferation, UN Member States are "convinced that the most effective way to achieve an end to nuclear testing is through the conclusion of a universal and internationally and effectively verifiable comprehensive nuclear test-ban treaty [1]". Therefore about 90 % of the planned 321 monitoring stations and 16 radionuclide laboratories, are currently established to support the monitoring of any nuclear explosions around the globe. To provide States Signatories with the necessary support to participate effectively in the global verification monitoring, the CTBTO offers services and technical assistance to them. The CTBTO through the Capacity Building project engages States Signatories to integrate them to participate and contribute to the implementation of monitoring and verifying the Treaty**.** Under this project, States Signatories are provided with sufficient knowledge and assistance to build their NDCs and/or improve their capabilities. The CTBT's verification regime beyond its core purpose of monitoring all nuclear explosions around the world, offers data that has wide civil and scientific applications for the greater benefits to humanity. Additional benefits of the Treaty are the value-added advantages of non-treaty relevant applications of the monitoring data in addition to its

significance to arms control and global security. Also, the CTBTO while working on the verification system to accomplish its prime purpose of establishment, it is offering States Signatories the added opportunities to access relevant scientific and technological advances to the system. As part of the technical support programme under the CBS project, the Republic of Ghana in July 2021 was a beneficiary of GCI-III/VSAT equipment support received from the CTBTO. This global communication link to IDC is a vital element in the near-real-time monitoring data forwarding process to NDC – GH, as part of the capacity building project. Thus, the CTBT is playing a strong and value-added role in the capacity building process to States Signatories beyond the core objective of monitoring and verifying nuclear explosions across the globe. From the afore mentioned added benefits of the CTBT to Member States, it is important for the international community to recognize the need to fashion out global agreement in terms of Treaty, Convention among others such that it has derived additional benefits to the Signatory States aside the core purpose. These added-value benefits will in turn serve as a motivation and draws States interest to the core multilateral agreement.

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References

[1] United Nations Department for Disarmament Affairs & United Nations Department of Public Information. (1998). CTBT: Comprehensive Nuclear-Test-Ban Treaty. United Nations Department for Disarmament Affairs and Department of Public Information. Vienna.

[2] CTBTO Prep Comm. (2022) Guidebook for IDC Users on IMS data, IDC Products and technical assistance available to States Signatories. International Data Centre Division, version 1.2, Vienna, Austria.

[3] Coyne, J., Bobrov, D., Bormann, P., Duran, E., Grenard, P., Haralabus, G., Kitov, I., Starovoit, Y. (2012): CTBTO: Goals, Networks, Data Analysis and Data Availability. - In: Bormann, P.

(Ed.), New Manual of Seismological Observatory Practice 2 (NMSOP-2), Potsdam: Deutsches GeoForschungsZentrum GFZ, 1-41.

[4] Kebeasy, R. (2008). The CTBTO international monitoring system and global seismicity. In Earthquake monitoring and seismic hazard mitigation in Balkan Countries (pp. 113-120). Springer Netherlands.

[5] Asada, M. (2002). CTBT: Legal Questions Arising From its Non-Entry-Into-Force. Journal of Conflict & Security Law, 7(1), 85–122. http://www.jstor.org/stable/26294340

[6] Johnson, R. (2009). Unfinished business: The negotiation of the CTBT and the end of nuclear testing. United Nations Institute for Disarmament Research, Geneva.

[7] CTBTO (2023c) https://www.ctbto.org/resources/for-member-states/membership-benefits

[8] Sato, M. (2021) Advancing Nuclear Test Verification without Entry into Force of the CTBT, Journal for Peace and Nuclear Disarmament, 4:2, 251-267, DOI: 10.1080/25751654.2021.1993643

[9] CTBTO (2023a). https://www.ctbto.org/our-mission/states-signatories

[10] CTBTO (2023b) https://www.ctbto.org/news-and-events/news/new-web-section-workshops-and-training

[11] Amponsah,P.E and Serfor-Armah,Y.(2013). Ghana's experience in the establishment of a National Data Center. Earthq Sci, 26, pp1-5.

[12] Avenhaus R., Kyriakopoulos N., Richard M., and Stein G. (eds) (2006) Verifying Treaty Compliance: Limiting Weapons of Mass Destruction and Monitoring Kyoto Protocol Provisions Berlin-Heidelberg: Springer.

[13] CTBTO (2023c). https://www.ctbto.org/news-and-events/news/fact-sheet-tremendous-progress-build-ctbts-verification-regime

[14] Kalinowski, M.B., Sarid, E., Mialle, P., Zampolli, M., & Haralabus, G. (2023). Innovation in Technology and Scientific Methods for Nuclear Explosion Monitoring and Verification: Introduction. Pure and Applied Geophysics, 180, 1227 - 1234.

[15] Kalinowski, M.B., Becker, A., Saey, P.R., Tuma, M.P., & Wotawa, G. (2008). The complexity of CTBT verification. Taking noble gas monitoring as an example. Complex., 14, 89-99.

[16] Amponsah, P. and Osae, S. (2014). Potential Benefits of the Comprehensive Nuclear-Test-Ban Treaty Organization to Ghana. Environmental Research, Engineering and Management, No. 1(67), P. 65–70.

[17] National Research Council (2012). The comprehensive nuclear test ban treaty: technical issues for the United States. National Academies Press.

[18] CTBTO Prep Comm. (2013d) Guide to CTBT National Implementation Measures (Commentary and Model Provisions). International Data Centre Division, Vienna, Austria.

[19] CTBTO (2023e). https://www.ctbto.org/map/

[20] Hoffmann, W., Kebeasy, R., & Firbas, P. (1999). Introduction to the verification regime of the comprehensive nuclear-test-ban treaty. Physics Earth Planetary Interiors, 113, 5–9.

[21] CTBTO (2023f). https://www.ctbto.org/our-work/verification-regime

[22] Dahlman, O., Mackby, J., Mykkeltveit, S., & Haak, H. (2011). Detect and deter: can countries verify the nuclear test ban?. Springer Science & Business Media.

[23] CTBTO (2021). https://press.un.org/en/2021/sc14645.doc.htm

[24] CTBTO (2008). https://www.ctbto.org/press-centre/press-releases/2008/signing-of-tsunami-warningagreementbetweenjapan-and-the-ctbto/

[25] CTBTO (2023g)**.** https://www.ctbto.org/resources/for-the-media/press-releases/ctbt-offers-signatory-states-additional-benefits

[26] CTBTO. (2005). https://www.ctbto.org/resources/for-the-media/press-releases/northern-sumatra-earthquake-and-subsequent-tsunami-26

[27] CTBTO. (2011). https://www.ctbto.org/news-and-events/news/fukushima-related-measurements-ctbto.