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Expanding the Peaceful Uses of Nuclear Technology and Climate Change Adaptation: Opportunities and Challenges

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While ongoing debates on the critical role of nuclear power plants in achieving the goals established in the 2015 Paris Agreement remain unsettled, the peaceful applications of nuclear technology in climate change adaptation have been expanding in recent years. The peaceful uses of nuclear technology cannot be excluded from innovative approaches to addressing the world's most pressing and complex challenge– climate change. This NTS Insight examines how nuclear technology can be deployed to strengthen climate adaptation measures and presents case studies from several Southeast Asian countries that have nuclear research and scientific programmes. Nuclear technology is being utilised in adopting climate-smart agriculture, modernising water management, enhancing greenhouse gas emissions analysis, and combatting plastic pollution. This Insight offers agendas for action by Southeast Asian countries to address key challenges to expanding the role of nuclear technology in addressing climate change.

The author conducted a research tour at the Philippine Nuclear Research Institute in May 2022.
Photo Credit: Julius Trajano/NTS Centre

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Introduction

In recent years, climate change adaptation has received increased attention vis-à-vis mitigation. Through their national plans of action on climate change, many countries have launched various national-level adaptation measures, particularly in the agriculture sector and water resource management, Even developing countries, which have long been suffering from the worsening effects of climate change, have actionable adaptation policies in place with implementation guidelines. Globally, there is a rising number of adaptation projects in developing countries, being funded by multilateral and bilateral technical assistance.[1]

Adaptation involves modifications in ecological, social, or economic systems in response to actual or expected climatic changes and their effects or impacts. It entails changes in processes, practices, and structures to cushion destructive effects or seek opportunities associated with climate change. Basically, countries and communities should seek and deploy adaptation solutions to respond to the concurrent and emerging impacts of climate change.[2]

Technological solutions are intended to strengthen resilience and minimise vulnerabilities in multiple areas, many of which are relevant to the non-power applications of nuclear technology. These include land use and management, climate smart agriculture, food production systems, analysis of greenhouse gas (GHG) emissions, management of water resources. and ocean and coastal protection.

This NTS Insight examines how nuclear technology can be deployed to strengthen climate adaptation measures and presents case studies from several Southeast Asian countries that have nuclear research and scientific programmes. It discusses how the contributions of nuclear technology have been increasingly applied in Southeast Asia, particularly in adopting climate-smart agriculture, modernising water management, enhancing greenhouse gas emissions analysis, and combatting plastic pollution. Several challenges to the full integration of nuclear technology into national climate adaptation strategies are likewise highlighted.

[1] IAEA, *Nuclear Science and Technology for Climate Adaptation and Resilience A Reference Document* (Vienna: IAEA, 2021).
[2] UN Climate Change, "What do adaptation to climate change and climate resilience mean?", https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean (accessed 21 June 2022).

The Nexus Between Climate Adaptation and Nuclear Technology

While ongoing debates on the critical role of nuclear power plants in achieving the goals established in the 2015 Paris Agreement remain unsettled, the peaceful applications of nuclear technology in climate change adaptation have been expanding in recent years.

The nuclear discussions at COP26 in Glasgow demonstrated how governments, farmers and scientists can boost resilience to the impacts of climate change and institutionalise more sustainable management of land and water resources using nuclear science and technology. Nuclear technologies are deployed to advance climate science and/ or support Member States in adapting to climate change

For instance, nuclear and related techniques can boost agricultural resilience to climate change, in reducing greenhouse gas emissions, and in increasing agricultural productivity – altogether known as climate-smart agriculture. Nuclear techniques, such as mutation breeding, can boost food production systems as this technology can produce climate-resilient varieties of crop species, which can thrive under stressful climatic conditions. This technology has helped improve many crops so that they can perform better. Various nuclear techniques can also be deployed to monitor and control agrochemical inputs such as fertilizers, as well as reduce the possibility of contaminating the environment and, ultimately, the food supply chain with these inputs.[3]

The International Atomic Energy Agency's (IAEA) Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific (RCA) is a ground-breaking mechanism in measuring the impact of IAEA-supported mutation plant breeding activities in Asia and the Pacific, spanning nearly 20 years and 22 countries, including Southeast Asian countries. Over 7,300 promising breeding lines with superior quality traits to previous crops and 254 mutant varieties of crops were officially released under the RCA in the Asia-Pacific. Innovative results of this project that are relevant for climate change adaptation include: (i) higher yield productivity, with a 32.7 percent increase in total production over their respective control crops; (ii) improved food supply, generating an additional 34.8 million tonnes of produce from 2000 to 2019; (iii) lower use of agricultural inputs by 21 percent for chemical fertiliser, 17 percent for pesticides, 12 percent for irrigated water, and increased soil fertility by 8% for the period 2000–2019); and (iv) more competitive market prices of sampled agricultural crops as a result of better nutritional and environmental quality traits.[4]

Nuclear techniques have important roles to play in water management. In addressing water scarcity caused by the changing climate, a form of nuclear technique known as isotope hydrology can help countries monitor valuable groundwater resources, supporting decision makers in developing sustainable water use policies.[5] An improved understanding of the status of groundwater sources, including their underground flows and modes of replenishment, helps to determine how resilient groundwater sources are to climate change, as well as vulnerability to pollution. Nuclear techniques are also being used for agricultural water management, such as developing water-saving technological packages, determining sources of pollution, and tracking water movement and pathways in agricultural landscapes with different cropping systems and farming practices.[6]

[3] Discussions at the IAEA at COP26 Conference on Contribution of Nuclear Science and Technology to Climate Change Adaptation, Glasgow, the UK, 6 November 2021.
[4] IAEA, *Nuclear Science.*
[5] Puja Daya, "IAEA Supports Improved Aquifer Management in Climate Change Affected Namibia," IAEA, 10 August 2021, https://www.iaea.org/newscenter/news/iaea-supports-improved-aquifer-management-in-climate-change-affected-namibia#infobox.
[6] IAEA, "*Nuclear Science".*

Another area where nuclear technology can make an impact is marine environmental protection. In the area of ocean and coastal protection, nuclear techniques are used to detect and determine various issues affecting marine ecosystem, such as atmosphere/ocean exchange, marine radioactivity, coastal and marine carbon sequestration, sea-level rise and ocean acidification.[7] The IAEA is at the forefront of deploying nuclear science and technology to address ocean plastic pollution through its new initiative, the Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastic), which aims to explore and rapidly expand the use of nuclear technology to combat ocean plastic pollution and reduce plastic waste globally. Nuclear techniques can contribute to the assessment of the dimension of the plastic pollution as well as to the recycling of plastic through radiation techniques.

The UNEP Report, which was released for the 2021 United Nations Climate Change Conference (COP26) in Glasgow, the UK, highlights that plastic pollution is clearly a climate problem as well. For example, in 2015, greenhouse gas emissions from the production, use and disposal of fossil fuel-based plastics were 1.7 gigatonnes of CO2 equivalent. By 2050, these emissions will rise to approximately 6.5 gigatonnes, comprising 15 perceng of the whole global carbon budget ─ the amount of greenhouse gases that can be emitted while keeping warming below a specific temperature goal set by the Paris Agreement.[8]

Nuclear Technological Applications in Southeast Asia

The peaceful uses of nuclear technology have been increasingly applied in Southeast Asia. Nuclear technology has helped farmers grow rice that can cope with the diverse and harsh effects of climate change. Recent innovations from Indonesia, Malaysia, the Philippines, Thailand and Vietnam have shown how farmers were able to boostrice production and plant better crops in harsh climate conditions in the past five years with the help of nuclear techniques.[9]

Climate-Smart Agriculture

Using mutation-induced breeding, nuclear scientists in the Philippines were able to develop new, improved varieties of rice and other food crops which are more resilient to pests and to the destructive effects of typhoons. They found that an extract of seaweed (called carrageenan), when processed with radiation, can make agricultural crops more resistant to typhoons and raise rice production by 20–30 percent. Agricultural researchers at the National Crop Protection Center of the University of the Philippines tested the benefits of carrageenan as a plant growth promoter on more than 5,000 hectares in Bulacan, an agriculture-dependent province. The IAEA provided the irradiators (a nuclear technique equipment) and the training of local experts on their use. Researchers measured that sprayed areas generated stronger crops with harvests 65 percent above that of the normally treated crops. But more significantly, when a strong typhoon hit the province in 2015, only the rice plants treated with the new growth promoter remained standing.[10]

Among these applications are the Carrageenan Plant Growth Promoter (PGP) formulated to increase the yield of rice crops by more than 20 percent, and make the plants more resistant to blight and infestation. Born out of the successful IAEA Technical Cooperation Program between the Philippines and the IAEA, the Carrageenan PGP is now available in the market and is already being used by farmers across the country. Through nuclear science, the Department of Science and Technology - Philippine Nuclear Research Institute (DOST-PNRI) continues to develop new varieties of

[7] Ibid.
[8] United Nations Environment Programme, *From Pollution to Solution: A global assessment of marine litter and plastic pollution* (Nairobi: UNEP, 2021).
[9] Laura Gil, "Nuclear Technology Helps Southeast Asia Boost Climate-Proof Rice, Experts Demonstrate," IAEA, 20 September 2017, https://www.iaea.org/newscenter/news/nuclear-technology-helps-southeast-asia-boost-climate-proof-rice-experts-demonstrate.
[10] UN Philippines, "IAEA contributions to PHL show how "atoms" can be used for peace and development," 12 October 2020, https://philippines.un.org/en/95272-iaea-contributions-phl-show-how-atoms-can-be-used-peace-and-development.

plants with unique or improved characteristics. These traits can be induced from plants through the marvels of mutation breeding using gamma rays. Among these traits of new varieties are changes in colour, size or height, increase in yield, early maturity, resistance to pests and diseases or tolerance to drought, flooding, acid soils, salinity and high temperatures, among others.[11]

In Laos, the IAEA, in cooperation with the Food and Agriculture Organization (FAO), supported local farmers and managed to increase rice yields through better soil and nutrient management practices using nuclear techniques. Rice yields have increased from 3.16 to 5.1 tonnes per hectare, or a 60 percent increase, with the use of nuclear science. The IAEA, through its technical cooperation programme, has trained researchers in using the stable isotope nitrogen-15 to quantify the amount of nitrogen plants take up from fertilizers, and then determine the precise amount of fertilizer that farmers should use at various stages of the crop's life. [12]

In Indonesia, 22 rice varieties have been developed by the National Nuclear Energy Agency's (BATAN) scientists through a process known as mutation breeding. The mutation process generates random genetic variations, resulting in plants with new and useful traits. BATAN scientists use gamma irradiation to induce mutations in seeds and considerably speed up the natural mutation process. Indonesian scientists tested the new mutant plants for various characteristics and selected those displaying useful traits for further breeding and subsequent distribution to farmers.

Tempeh, made of fermented soybeans, is a national staple, usually consumed with rice and broth. Due to an increase in population and living standards, however, consumption has grown considerably. Indonesia has gradually lost its self-sufficiency in tempeh production with the production affected severely by changing climate patterns. It is now importing close to 60 percent of the 2.2 million tons of soybeans consumed each year. The Indonesian government would like to significantly increase its domestic production. The Ministry of Agriculture selected a variety developed by the BATAN's nuclear scientists for mass seed production and distribution among farmers. The variety called Mutiara 1 was developed using irradiation, a nuclear technique. According to farmers in the heart of the country's soybean-growing area in East Java, the plants are shorter and stronger, tolerant to wind and resistant to disease. Even more importantly, the yield — at above 3 tons per hectare — is 25 percent higher than that of local varieties. [13]

Cleaner rivers and higher yielding crops are just some of the myriad benefits nuclear technology has brought to Vietnam in recent years. For years, the Nhue River in Vietnam suffered from excessive plant and algae growth which severely affected fishing, tourism and irrigation. This threatened the well-being of over 200,000 people. Using stable isotopes, Vietnamese experts, supported by the IAEA and FAO, identified excessive fertilizer use on nearby farms as the culprit. Farmers have since changed their fertilizer practices, which has led to reduced river pollution and improved water quality. The Mekong River is an important river for Vietnam's agricultural development. But it is severely affected by drought and increasing salinity. Climate change is exacerbating these problems and threatening food security. Through seed irradiation, Vietnamese scientists have developed new varieties of rice that are drought tolerant and higher yielding, which has benefited over 300,000 Vietnamese farmers.[14]

[11] Interview with Philippine nuclear scientists, Quezon City, the Philippines, 26 May 2022. Philippine Nuclear Research Institute, "Better Food Crop Varieties Through Nuclear Science," 6 April 2021, https://www.pnri.dost.gov.ph/index.php/2-uncategorised/688-better-food-crop-varieties-through-nuclear-science. Conducting these interviews was approved by the Institutional Review Board of Nanyang Technological University (NTU-IRB Reference: IRB-2020-06-044) and was part of the research project supported by the Singapore Ministry of Education (MOE) Academic Research Fund Tier 1 Grant.

[12] Liu Han, "Improved Soil and Nutrient Management Practices Increase Rice Yields in Lao PDR," 20 January 2021, https://www.iaea.org/newscenter/news/improved-soil-and-nutrient-management-practices-increase-rice-yields-in-lao-pdr.

[13] Miklos Gaspar, "Fighting climate change: Rice variety developed with nuclear techniques expands in Indonesia," *IAEA Bulletin*, March 2018.

[14] Puja Daya, "Nuclear science and technology support Viet Nam's development," *IAEA Bulletin*, December 2021.

Water Management

Southeast Asian countries have just started to explore the water management application of nuclear technology. In the Philippines, PNRI collaborates with local Philippine universities in conducting hydrology studies to improve local water management in light of the impact of climate change on water resources. The collaboration is part of the Smart Water Infrastructure Management (SWIM) Research Project, which aims to introduce pioneering water management approaches, technologies, and innovation that will address drought, flooding, and sedimentation in several northern Philippine provinces. It will also develop a water resources management masterplan for local governments, and policies and guidelines on integrated water resources management.[15]

In 2019, an agreement was signed between the Vietnam Atomic Energy Institute (VINATOM) and the IAEA, officially designating VINATOM as an IAEA Collaborating Centre for Water and Environment. The Centre focuses on promoting the use of nuclear techniques for holistic water and environment assessment, monitoring and management in Vietnam, as well as broader integrated watershed and coastal area management in Southeast Asia. The proposed areas of collaboration include air quality assessment and monitoring, soil and agricultural research, water resource research and analysis, marine environment research and analysis, climate change research, training and quality control and communication.[16] This is crucial for Vietnam in light of the impact of climate change on its water resources. Vietnam is a tropical monsoon coastal country, which is now affected severely by climate change and faces many environmental issues. Therefore, a lot of nuclear and isotope techniques at the IAEA can be applied in Vietnam to assess water resources, traceability of pollutants, or environmental treatment.[17]

Greenhouse Gas Emissions Analysis

Southeast Asian countries can also utilise nuclear science to analyse greenhouse gas emissions through their air pollution analysis projects. As part of its studies on the application of nuclear and nuclear-related analytical techniques, PNRI monitors and determines the sources of air pollution in key Philippine metropolitan areas, measures the concentrations of air pollutants, and traces where these pollutants are coming from. In cooperation with the Department of Environment and Natural Resources – Environmental Management Bureau (DENR-EMB) and the Australian Nuclear Science and Technology Organisation (ANSTO), PNRI used Gent Samplers to collect air particulates twice a week in five air pollution monitoring stations in Metro Manila, a major source of the country's greenhouse gas emissions. To identify the sources and volume of air pollutants, PNRI uses receptor modelling to trace the pollutants from the environment to the source. PNRI scientists are also able to trace the path of pollutants by analysing wind direction for particulates carried into the air.[18]

Similarly in Indonesia, BATAN's nuclear scientists analyse air quality samples from 17 cities across Indonesia. In October 2017, following the use of various nuclear techniques for air quality assessment, Bandung, Indonesia's third largest city, was awarded the title of ASEAN Environmentally Sustainable City. Located in West Java, the city has been deploying these techniques since the late 1990s to measure particulate matter in the city's air on a regular basis.[19]

[15] Philippine Nuclear Research Institute, "Nuclear techniques eyed for more precise hydrology studies," 21 March 2022, https://pnri.dost.gov.ph/index.php/2-uncategorised/726-nuclear-techniques-eyed-for-more-precise-hydrology-studies.

[16] Sarah Kiehne, "Viet Nam's Atomic Energy Institute, VINATOM, Signs New Collaborating Centre Agreement with the IAEA," IAEA, 29 Nov 2018, https://www.iaea.org/newscenter/news/viet-nams-atomic-energy-institute-vinatom-signs-new-collaborating-centre-agreement-with-the-iaea.

[17] Tuah Minh," IAEA-VINATOM center for water and environment inaugurated in Hanoi," *Hanoi Times*, 4 April 2019, http://hanoitimes.vn/iaea-vinatom-center-for-water-and-environment-inaugurated-in-hanoi-42512.html.

[18] Philippine Nuclear Research Institute, "PNRI Conducts Air Pollution Studies with Nuclear Analytical Techniques," 24 April 2017, https://pnri.dost.gov.ph/index.php/2-uncategorised/479-pnri-conducts-air-pollution-studies-with-nuclear-analytical-techniques.

[19] Omar Yusuf, "World Environment Day 2019: Deploying Nuclear Science to Help Keep Our Air Clean," IAEA, https://www.iaea.org/newscenter/news/world-environment-day-2019-deploying-nuclear-science-to-help-keep-our-air-clean.

Combatting Plastic Pollution

Indonesia vows to play a key role in the IAEA's Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastics) initiative. NUTEC Plastics provides a platform for cooperation to combat plastic pollution and leverage the resources, knowledge and networks of participating countries. Indonesia is aiming to reduce its marine litter by 70 percent in the next four years. With support from NUTEC Plastics, it plans to build a pilot facility that uses irradiation to recycle plastics, and will share its gained expertise with specialists from other countries.[20]

In the Philippines, an improved way of recycling plastic waste has just been introduced by the PNRI. It has begun using irradiation nuclear technique to increase the thermomechanical properties of recycled mixed plastic, enabling a wider and higher-value reuse. With this nuclear technique, the resulting recycled plastic is further strengthened and made sturdier. These plastic pellets can be used for a wide variety of uses, including even high-value products such as construction materials. Given that the irradiation equipment at PNRI is small, there is an evident limitation to the quantity of plastic waste that can be recycled through irradiation.[21] Nonetheless, it can clearly demonstrate that plastic waste can be recycled using nuclear techniques. At industrial scale, bigger irradiators will be needed which can significantly help the country reduce its plastic waste and its contribution to greenhouse gas emissions.[22]

Challenges to Expanding the Peaceful Uses of Nuclear Technology

Limited State Support to Research and Development

One key challenge to the expansion of the use of nuclear techniques is the limited state funding for research and development projects. In Southeast Asia, most of the nuclear research and scientific initiatives are done by state-run nuclear research institutes. With the limited funding, such projects can only be done on a small scale; there are delays in completing the scientific outcomes; and the number of potential beneficiaries, such as farmers, is still low. There is a need for more fiscal support from national governments to transform existing initiatives into large scale, high impact projects so that there can be more vulnerable sectors that can benefit from climate adaptation-oriented nuclear technology projects.[23] While the scientific community generally understands the potential of nuclear science and technology for climate adaptation, decision-makers, and the broader development and financing communities, are not. One example of the lack of understanding and appreciation of the potential contributions of nuclear science is the misconception that "nuclear technology" is inherently dangerous, equating it to nuclear weapons, radioactive contamination and accidents at nuclear power plants. This inaccurate perception is often based on three global nuclear accidents (Three Mile Island, Chernobyl and Fukushima accidents) and its false association with nuclear weapons.[24] Some legislators in the Philippines, for instance, have a misconception that by simply legislating a comprehensive nuclear law, the country will automatically pursue nuclear energy and build nuclear power plants. This misconception may undermine the inclusion of other peaceful uses of nuclear science with climate change adaptation strategy.[25] As a result, the contribution of nuclear technologies in support of climate adaptation solutions rarely features in nationally determined contributions (NDCs) or as part of multi-stakeholder initiatives.[26]

A good practice recommended by the IAEA is involving parliamentarians in briefings and workshops to raise their awareness and understanding of the scope and content of a comprehensive nuclear law early in the legislative

[20] Elodie Broussard, "How developing countries are helping each other use nuclear technologies," IAEA Bulletin, December 2021.
[21] Interview with Philippine nuclear scientists, Quezon City, the Philippines, 26 May 2022.
[22] IAEA, " Plastics: With Irradiation Towards a Circular Economy," 26 May 2022, https://www.iaea.org/newscenter/multimedia/photoessays/nutec-plastics-with-irradiation-towards-a-circular-economy.
[23] Interview with Thai nuclear scientist, Zoom, July 2020; Interview with Philippine nuclear scientists, Quezon City, the Philippines, 26 May 2022.
[24] Interview with Southeast Asian regulatory officials, Aug 2020 and May 2022.
[25] Interview with a Philippine regulatory official, Manila, Philippines, 26 May 2022.
[26] IAEA, *Nuclear Science*

approval process.[27] For instance, members of the parliament and legislators from Southeast Asian countries occasionally visit the IAEA and receive briefings from IAEA officials on various technical capacity building programmes, including the peaceful uses of nuclear science.[28] Through its regional projects, the IAEA has been supporting countries in the Asia-Pacific to introduce nuclear science in secondary schools and promote the science, technology, engineering and mathematics (STEM) approach.[29]

Technology Needs Assessment

Southeast Asian countries already have their respective national climate change action plans in place. These plans all accentuate the importance of utilising technological solutions to the worsening impact of climate change. Adaptive technology is recognised by these national plans as a capable tool to respond to the potential impacts of climate change and in line with development goals, cost-effective, environmentally friendly, culturally compatible, and socially acceptable.[30] Expanding the use of adaptive technologies would entail research, development, deployment, diffusion and transfer of necessary techniques which would depend largely on the cost and availability of technologies. This would require developing human capacity (knowledge and skills) and having an enabling environment for developing appropriate institutional mechanisms; and acquiring, accessing and ability to operate hardware and software of climate-friendly technologies.[31]

Currently, it appears that nuclear technology is not yet part of the national action plans and strategies on climate change adaptation. The peaceful uses of nuclear technology are often excluded from public and political discourse, creating significant challenges for the nuclear sector. Even in countries that include nuclear power in their existing and future energy plans, climate change adaptation policies often remain silent on the role of nuclear science and mechanisms to expand government support for research and development in nuclear science. In this regard, there is a need to proactively engage policy makers on the latest nuclear and radiation-related innovations as well as the growing role of nuclear science in attaining sustainable development goals, including taking urgent action to combat climate change and its impacts.[32] One way to address this challenge is to explore policy roundtables and public forums on the nexus between climate adaptation and nuclear technology.

Regulatory Framework and Capacity

The successful transfer of technology goes beyond the exchange of technological solutions. It essentially requires enabling policy and regulatory environments as well as adaptive capacities to absorb, employ and tailor these technologies, methods or techniques.[33] Regulatory capacity must also be expanded. This means additional nuclear regulators as the applications of nuclear science continue to expand, in medicine, agriculture, industry, scientific research and even climate adaptation. Regulatory inspections are needed to ensure that radioactive sources being used for such peaceful uses cannot be diverted to non-peaceful acts (crimes and terrorist acts).

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[27] IAEA. *Report of the Phase 1 Integrated Nuclear Infrastructure Review Mission to the Philippines, 10–17 December 2018*. https://www.iaea.org/sites/default/files/documents/review-missions/inir-report-philippines-171218.pdf.

[28] VNA, "Top Vietnamese legislator meets with IAEA leader," *Vietnam+*, 7 September 2021. https://en.vietnamplus.vn/vietnamese-na-chairman-meets-with-iaea-leader/207543.vnp; Fanny Tonos Paniagua, "Philippines's Delegation Led by the Senate President Briefed on Nuclear Law, Technical Cooperation Programme," IAEA, 10 May 2018. https://www.iaea.org/newscenter/news/philippiness-delegation-led-by-the-senate-president-briefed-on-nuclear-law-technical-cooperation-programme.

[29] Bridget Carter, "Students and Teachers in Asia and the Pacific Share their Innovative Visions for Development using Nuclear Science and Technology," IAEA, 9 December 2021, https://www.iaea.org/newscenter/news/students-and-teachers-in-asia-and-the-pacific-share-their-innovative-visions-for-development-using-nuclear-science-and-technology.

[30] Ministry of National Development Planning/ National Development Planning Agency (Bappenas) of Indonesia, National Adaptation Plan Executive Summary, 2019, https://lcdi-indonesia.id/wp-content/uploads/2020/05/Executive-Summary-NAP.pdf

[31] Climate Change Commission of Government of the Philippines, National Climate Change Action Plan 2011-2028, https://climate.emb.gov.ph/wp-content/uploads/2016/06/NCCAP-1.pdf.

[32] United Nations Sustainable Development Goals, Goal 13: Take urgent action to combat climate change and its impacts, accessed 27 June 2022, https://www.un.org/sustainabledevelopment/climate-change/. See for example Philippine Nuclear Research Institute, PH nuclear S&T innovations go online at Atomic Energy Week, 5 Nov 2020, https://www.pnri.dost.gov.ph/index.php/2-uncategorised/675-ph-nuclear-s-t-innovations-go-online-at-atomic-energy-week.

[33] IAEA, *Nuclear Science.*

It is crucial that states have updated and comprehensive regulatory frameworks governing the peaceful uses of nuclear technology in their respective countries, including licenses for the import, export, transport, sale, manufacture, dealing in, possession and use of radioactive materials and irradiating apparatus. The expanding uses of nuclear technology and emerging nuclear techniques must be complemented with more relevant and comprehensive regulatory frameworks. The overall objective is to guarantee that utilising nuclear technology is always safe and secure. Currently, Malaysia, the Philippines, Myanmar, and Indonesia have pending legislative bills or proposals to amend their outdated regulatory and legal frameworks. Amending national regulatory framework is also needed to establish independent nuclear regulatory agencies. In some countries like the Philippines, the promotion and regulation of nuclear technology are handled by just one agency. Singapore, Thailand and Vietnam have already updated and revised their respective national regulatory frameworks, comprehensive enough to reflect expanding uses of nuclear techniques. There is also a need to increase the number of regulators in view of the increasing number of users of radioactive sources for various nuclear techniques. One shared challenge among regulatory bodies in Southeast Asia is insufficient human resources. There is a need to increase the number of regulatory inspectors, given that there is already a growing utilisation of nuclear techniques, in particular for commercial, medical and climate adaptation purposes, that need to be regulated.[34]

Regional collaboration in using nuclear technology

Scientific cooperation among nuclear scientists in the region is also key to expanding and accelerating the application of nuclear science for climate adaptation. Currently, there are a few national initiatives from Southeast Asian countries to host fellowships, scientific visits and training courses in order to facilitate knowledge transfer among the region's nuclear scientists. But scaling up such national activities is necessary through more coordinated research projects. Currently, the Forum for Nuclear Cooperation in Asia (FNCA), a Japan-led cooperation framework for the peaceful uses of nuclear technology, provides an initial pathway to forge regional scientific cooperation in nuclear technological applications for climate adaptation in the Asia-Pacific. Commenced in 2017, FNCA's Research on Climate Change using Nuclear and Isotopic Technologies Workshop have facilitated information sharing among regional states on their respective projects on climate adaptation.[35] Moving forward, this must be utilised to forge coordinated research partnerships among the region's nuclear scientists.

ASEAN can leverage the resources and expertise of FNCA given that five of its member states are active FNCA participants (Indonesia, Malaysia, Philippines, Thailand and Vietnam). The ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM), an ASEAN sectoral body that serves as a framework for cooperation among nuclear regulatory bodies in Southeast Asia, can explore possible collaboration with the FNCA on climate change adaptation using nuclear technology. ASEANTOM members can organise coordinated research projects with FNCA's research study network on climate change. Such joint projects can build on the scientific outcomes of ongoing FNCA projects. Southeast Asian nuclear scientists, who actively participate in FNCA's climate change projects, can form a scientific consortium that facilitates sharing of findings, coordinates baseline studies and optimises joint resources (e.g., national laboratories, equipment).

Additionally, within Southeast Asia, there is a growing pool of nuclear scientists who can collaborate with other relevant environmental scientists and policymakers to develop and apply technologies for climate adaptation. The region's nuclear technology research and training centres should therefore be part of the multi-stakeholder collaboration which is critical in searching for innovative scientific solutions.

[34] Interview with Southeast Asian regulatory officials, Aug 2020 and May 2022.
[35] Forum for Nuclear Cooperation in Asia, Report of FNCA FY2021 Online Workshop on Research on Climate Change using Nuclear and Isotopic Technologies, 11-12 Nov 2021.

Conclusion

Today, there are still challenges to the expansion of the peaceful uses of nuclear energy and technology, due to misconceptions or concerns about them. There is a need to reframe nuclear issues as one that links nuclear technology with climate change adaptation. The misconceptions arising from issues of nuclear weapons proliferation, nuclear accidents such as in Fukushima and Chernobyl, and radioactive contamination, however, can be addressed by highlighting how nuclear technology actually helps countries achieve several of their commitments to the Paris Agreement and Sustainable Development Goals, particularly those pertaining to climate action. As demonstrated in the COP26 in 2021, the peaceful uses of nuclear technology cannot be excluded from innovative approaches to addressing the world's most pressing and complex challenge— climate change.

About the Author

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