

International Atomic Energy Agency's Analytical Laboratories for the Measurement of Environmental Radioactivity network: Experiences and perspectives in the North and Latin America region

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Abstract

The International Atomic Energy Agency (IAEA) Network of Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) is a worldwide network of laboratories capable of providing reliable and timely analysis of radionuclides in environmental samples during normal or accidental/intentional events that result in the release of radioactivity in the environment. ALMERA is coordinated by the Environment Laboratories of the IAEA and organized into five regional groups, including the North and Latin America region (NLAR), led by the Canadian Nuclear Safety Commission. Capacity building in the NLAR for the measurements of environmental radioactivity is achieved through qualitative study that consists of experiences of ALMERA core activities and perspectives of the regional initiatives, respectively. Outcomes' analysis showed that the ALMERA core activities have contributed to the improvements of the analytical capacity and capability, and the regional initiatives assisted in the strengthening of the collaboration and networking, in the NLAR region. The immediate impact of these achievements consisted of gaining technical competence in measuring environmental radioactivity and establishing a network of laboratories. In the long term, sustained efforts between ALMERA and the regional coordination will continue upgrading national and regional competence in the radio analytical services.

Keywords: Analytical Laboratories for the Measurement of Environmental Radioactivity, capacity building, collaboration, environmental radioactivity measurements, networking

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INTRODUCTION

The North and Latin America region widely uses nuclear applications in the medical, industrial, and research sectors for socioeconomic development including an extractive industry (e.g., mines, oil and gas, phosphate, and minerals), as well as research reactors and/or nuclear power plants. To verify that the health and safety of people and the environment are protected, monitoring programs are developed, implemented, and maintained by national institutions, stakeholders, or regulatory bodies.

The effective implementation of these monitoring programs requires laboratories with adequate capacity and capability to perform radioanalytical analyses with precision, accuracy, and using a variety of internationally validated radioanalytical procedures.

To address this growing need for measurement of radioactivity in environmental samples, a worldwide network of analytical laboratories was formed under the aegis of the International Atomic Energy Agency (IAEA). This network was named “Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA).” Its main goal is to pool the resources of participating laboratories to provide reliable and timely determination of radionuclides in samples used for both routine and emergency environmental monitoring.^[1]

The IAEA supports the ALMERA laboratories in their routine and emergency response environmental monitoring activities by organizing proficiency tests (PTs) and interlaboratory comparison exercises; developing validated analytical procedures for environmental radioactivity measurement; and organizing training courses and workshops (TW). The network also acts as a forum for sharing knowledge and expertise.

As of January 2019, the ALMERA network consists of 180 laboratories representing 90 countries, with membership not limited to one laboratory per country.^[2] For example, Europe (93), North and Latin America (16 laboratories), Asia Pacific (34), Middle East (13), and Africa (10).

The IAEA's Environment Laboratories are the central coordinator of the ALMERA network's activities, supported by five regional coordinating laboratories that are appointed for a period of 5 years. These laboratories are designated “as regional groups” and include Africa, Middle East, North and Latin America, Europe, and Asia Pacific [Figure 1].^[3]

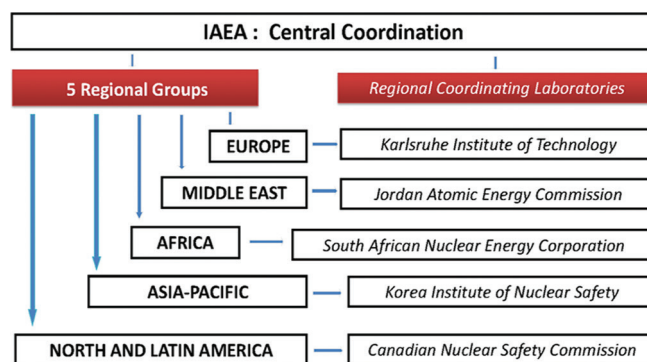


Figure 1: Analytical Laboratories for the Measurement of Environmental Radioactivity network coordination structure

The majority of the North and Latin America laboratories (NLAR) joined the ALMERA network at different time periods, and their effective participation varies from country to country.

In 2019, the NLAR consist of 11 countries: Argentina, Brazil, Canada, Chile, Costa Rica, Cuba, Jamaica, Mexico, Peru, Uruguay, and Venezuela, ranging from 1 to 3 laboratories per country [Figure 2].^[4]

The aim of this paper is to analyze and consolidate experiences and perspectives of the ALMERA core activities and the regional coordination initiatives, respectively.

MATERIALS AND METHODS

Considerable resources have been invested in recent years to improve laboratory capacity building in the ALMERA network. This qualitative study, focusing on the NLAR region, included two main data sources: experiences of the ALMERA core activities and perspectives of the coordination initiatives.

Experiences: ALMERA core activities

The IAEA helps the ALMERA network of laboratories to maintain their readiness by developing activities, including organization of PTs as a tool for external quality control (QC), development of standardized methods for sample collection and analysis, training and workshops for knowledge transfer and organization of meetings for review achievements, planning activities, and sharing experiences.

Proficiency tests

PTs are organized annually for members of the ALMERA network. Two types of reporting timelines are requested: (a) rapid reporting, within 3 days of sample reception; this reporting concerns gamma-ray-emitting radionuclides and aims to test the rapid response capacity of a laboratory;



Figure 2: Analytical Laboratories for the Measurement of Environmental Radioactivity membership in the North and Latin America Region. North America 4: Canada 2, Mexico 2. Central America 1: Costa Rica. Caribbean 3: Cuba 2, Jamaica 1. South America 8: Brazil 3, Peru, Argentina, Chile, Uruguay, Venezuela

and (b) normal reporting, within 3–4 months of receipt of the samples (depending on the exercise), for all radionuclides.^[5]

These exercises are designed to monitor and demonstrate performance and analytical capabilities of participating laboratories and to identify gaps and problem areas for which further development is required. In this context, two ALMERA PTs are presented in the results and discussion section.

Procedures

The procedures cover the determination of a large number of radionuclides from natural and anthropogenic origin in a wide range of environmental matrices, for both routine and emergency situations. Such tested and validated analytical procedures are essential tools for the production of reliable and comparable environmental radioactivity measurements.^[6]

Training courses and workshops

TW are regularly organized to give laboratory personnel the opportunity to refresh and update their knowledge,

expertise, and skills in their relevant work-related areas. The training courses may involve laboratory practical training, field work exercises, and real case studies or lectures, depending on the course content addressed by the training course or workshop. The training courses are tailored to the needs of the ALMERA laboratories.^[7]

Coordination meetings

The annual coordination meetings are held to review achievements and establish a future work plan for developing the network's activities. These activities include all ALMERA core activities described above. The meetings also provide a forum for sharing knowledge and expertise within this large network of expert laboratories.^[8]

Perspectives: NLAR coordination initiatives

The development of the coordination initiatives resulted from the joint efforts between the regional coordinator and the member laboratories. The approach to seek input from a variety of members consisted of two parts. In the first part, survey questionnaires to assess capacities and capabilities of the laboratories were designed and

Table 1: Proficiency tests

Years	Test	ALMERA	NLAR
2005	Determination of Sr-90, alpha and gamma emitters in the environmental samples	53	3
	Soil sampling interlaboratory comparison	10	2
2006	Gamma emitting RNs in water, soil, and grass	38	3
2007	Artificial and natural RNs in water, soil, and spinach	58	3
	Po-210 determination in water	36	2
2008	Naturally occurring radionuclides in phosphogypsum	49	5
2009	Gamma emitting RN in simulated air filters	69	11
2010	Ra-226 in soil and natural radionuclides in water	46	6
2011	Natural and artificial RNs in soil and water	57	6
2012	Natural and artificial RN in water, hay and soil	63	15
2013	Man-made and natural radionuclides in water and flour samples	76	15
2014	Anthropogenic radionuclides in water, seaweed, and sediment sample	71	18
2015	Anthropogenic and natural radionuclides in water, biota, and soil samples	82	16
2015	Interlaboratory comparison on gamma-ray spectra evaluation	106	18
2016	Natural and artificial RNs in water, vegetation, and sediment samples	82	18
2017	Natural and anthropogenic RNs in water, milk powder, and NORM samples	89	18
2018	Determination of anthropogenic and natural radionuclides in water and soil samples	98	18
Total participation		1083	177

ALMERA: Analytical Laboratories for the Measurement of Environmental Radioactivity, NLAR: North and Latin America region, RNs: Radionuclides, NORM: Naturally occurring radioactive material

Table 1a: Distribution of scores (%) for the three samples (NLAR scores are in parentheses)

Nuclide	Accepted			Not accepted			Warning			# reported results		
	S	G	W	S	G	W	S	G	W	S	G	W
⁴⁰ K		76 (100)			11 (0)			13 (0)			38 (2)	
¹³⁷ Cs	87 (50)	68 (50)	92 (100)	3 (50)	8 (50)	5 (0)	10 (0)	24 (0)	3 (0)	37 (2)	38 (2)	37 (2)
⁶⁰ Co	95 (100)		100 (100)	2 (0)		0 (0)	3 (0)		0 (0)	38 (2)		38 (2)
¹³⁴ Cs	92 (50)		76 (100)	3 (0)		5 (0)	5 (50)		19 (0)	37 (2)		37 (2)
¹⁰⁹ Cd	44 (100)		53 (0)	53 (0)		35 (0)	3 (0)		10 (100)	34 (2)		34 (2)
²¹⁰ Pb	60 (100)		43 (100)	33 (0)		43 (0)	7 (0)		14 (0)	30 (1)		28 (1)
²⁴¹ Am	70 (100)		84 (100)	9 (0)		10 (0)	21 (0)		6 (0)	34 (1)		36 (1)
⁶⁵ Zn	92 (100)		95 (100)	0 (0)		2.5 (0)	8 (0)		2.5 (0)	37 (2)		37 (2)
⁵⁴ Mn	80 (50)		90 (100)	2 (50)		5 (0)	18 (0)		5 (0)	37 (2)		38 (2)

S: Soil, G: Grass, W: Water, NLAR: North and Latin America region

processed. In the second part, an annual reporting was launched to picture needs and priorities.

RESULTS AND DISCUSSION

Experiences: ALMERA core activities

Proficiency tests

Table 1 lists the IAEA PTs and interlaboratory comparison exercises organized from 2005 to 2018.^[5] The PTs consisted of different exercises, including natural and artificial radionuclides in different matrices and samples (e.g., soil, water, vegetation, unprocessed food products, and aerosols). At least one exercise is organized per year by the IAEA for the ALMERA network.

The design and process of organizing and administering PTs is well described in the IAEA publications.^[9] From 2005 to 2018, ALMERA organized and administered 17 PTs. The number of participants ranged from 10 (2005) to 106 (2015), representing 10 and 47 member states, respectively.

The North and Latin America region participation NLAR scores varied from 2 (2005) to 18 (2015–2018). The total participants were 1083 and 177 for ALMERA and NLAR, respectively. The NLAR attendance represents approximately 16% of the total participation. This attendance is significant and comparable to the other regions (with the exception of Europe and Asia pacific) despite the average capacity and capability levels in the region.

Table 1 provides a list of PTs organized through ALMERA during the period 2005–2018. For illustration purposes, results and challenges of the two PT exercises focusing on

gamma- and alpha-/beta-emitting radionuclides analyses are summarized below.

Test 1 (2006): Determination of gamma-emitting radionuclides in water, soil, and grass

In this PT, 677 results were reported from 38 laboratories belonging to 29 different countries. The members were requested to analyze ⁵⁴Mn-, ⁶⁰Co, ⁶⁵Zn, ¹⁰⁹Cd, ¹³⁴Cs, ¹³⁷Cs, ²⁴¹Am, and ²¹⁰Pb in three matrices: water, soil, and grass. The methodology and the detailed results are presented in an IAEA report.^[10] Table 1a summarizes the evaluation of the reported results.

Most participants in this PT were able to quantify all the nuclides in the three matrices with acceptable trueness and precision. The overall evaluation showed that 78% of all reported results fulfilled the PT.

The evaluation results demonstrate that the measurement results of ⁴⁰K, ⁵⁴Mn, ⁶⁰Co, ⁶⁵Zn, ¹³⁴Cs, ¹³⁷Cs, and ²⁴¹Am are acceptable. However, the results for ¹⁰⁹Cd and ²¹⁰Pb in soil and water were not acceptable.

For ¹⁰⁹Cd, there was overestimation of the peak area due to unresolved interference around the 88 keV region in a densely populated X-ray region which is difficult to resolve. With respect to ²¹⁰Pb, results show a significant bias and incomparability between the laboratories. This can be attributed to inappropriate detector calibration in the low energy range and to the overestimation or underestimation of the self-attenuation factor.

Regarding a grass sample, the laboratories showed the lowest performance (only 68% of the laboratories

Table 1b: Distribution of scores (%) for water and soil samples (NLAR scores are in parentheses)

Nuclide	Accepted		Not accepted		Warning		Not reported	
Water samples 1, 2, 3								
HTO	52 (14.3)	44 (0)	54 (14.3)	8 (0)	18 (14.3)	16 (14.3)	6 (0)	4 (0)
¹³⁷ Cs-	94 (71.4)	88 (57.1)	90 (71.4)	4 (14.3)	8 (28.6)	6 (14.3)	2 (0)	4 (0)
⁶⁰ Co	86 (42.8)	88 (57.1)	84 (57.1)	6 (14.3)	8 (14.3)	10 (14.3)	8 (28.6)	4 (14.3)
¹³⁴ CS	80 (71.4)	84 (71.4)	70 (42.8)	6 (14.3)	10 (14.3)	10 (14.3)	14 (0)	6 (0)
¹⁵² Eu	66 (42.8)	76 (57.10)	78 (71.4)	18 (28.6)	18 (28.6)	12 (14.3)	16 (14.3)	6 (0)
Soil sample								
⁴⁰ K	86 (57.10)		6 (14.3)		4 (14.3)		4 (14.3)	
¹³⁷ Cs	96 (71.4)		2 (14.3)		2 (14.3)		0 (0)	
²¹⁰ Pb	50 (28.6)		16 (0)		4 (0)		30 (71.4)	
²²⁶ Ra	48 (28.6)		30 (42.8)		4 (0)		18 (28.6)	
²³⁴ U	16 (0)		24 (0)		4 (0)		56 (100)	
²³⁸ U	24 (0)		28 (0)		8 (14.3)		40 (85.7)	
⁹⁰ Sr	N/A (0)		N/A (0)		N/A (0)		N/A (100)	
²¹⁴ Pb	50 (28.6)		40 (42.8)		0 (0)		10 (28.6)	
²¹⁴ Bi	34 (0)		58 (71.4)		0 (0)		8 (28.6)	
²⁴¹ Am	N/A (0)		N/A (0)		N/A (0)		N/A (100)	

N/A: Not available, HTO: Tritiated Water

produced an acceptable result) for ^{137}Cs . This can be due to an incorrect calibration for this type of matrix and/or to an incorrect evaluation of the moisture content.

As an indication, the NLAR scores are presented in parentheses in Table 1a. The participation is very low and performance is acceptable and comparable to the ALMERA compilation.

Table 2: Developed and published procedures

Number	Procedure
1	A procedure for the rapid determination of Pu isotopes and ^{241}Am in soil and sediment samples by alpha spectrometry, <i>IAEA Analytical Quality in Nuclear Applications Series No. 11, 2009</i>
2	A procedure for the determination of ^{210}Po in water samples by alpha spectrometry, <i>IAEA Analytical Quality in Nuclear Applications Series No. 12, 2009</i>
3	Determination of radium isotopes in environmental samples, <i>Analytical Quality in Nuclear Applications Series No. 19, 2010</i>
4	Rapid Simultaneous Determination of ^{89}Sr and ^{90}Sr in Milk: A Procedure Using Cerenkov and Scintillation Counting, <i>IAEA Analytical Quality in Nuclear Applications Series No. 27, 2013</i>
5	A Procedure for the Sequential Determination of Radionuclides in Phosphogypsum: Liquid Scintillation Counting and Alpha Spectrometry for ^{210}Po , ^{210}Pb , ^{226}Ra , Th and U Radioisotopes, <i>IAEA Analytical Quality in Nuclear Applications Series No. 34, 2014</i>
6	A Procedure for the Sequential Determination of Radionuclides in Environmental Samples: Liquid Scintillation Counting and Alpha Spectrometry for ^{90}Sr , ^{241}Am and Pu Radioisotopes, <i>IAEA Analytical Quality in Nuclear Applications Series No. 37, 2014</i>
7	A Procedure for the Rapid Determination of ^{226}Ra and ^{228}Ra in Drinking Water by Liquid Scintillation Counting, <i>IAEA Analytical Quality in Nuclear Applications Series No. 39, 2014</i>

IAEA: International Atomic Energy Agency

Test 2 (2011): Determination of natural and artificial radionuclides in soil and water

Fifty-one of the 57 ALMERA laboratories initially reported their results to IAEA. The PT consisted of three water samples and one soil sample. The participating laboratories were requested to analyze ^3H , ^{60}Co , ^{134}Cs , ^{137}Cs , and ^{152}Eu in water and ^{40}K , ^{90}Sr , ^{137}Cs , ^{210}Pb , ^{226}Ra , ^{234}U , and ^{238}U , in soil. The detailed results along with the statistical performance evaluation were compiled and presented in the IAEA report.^[11] Table 1b summarizes the evaluation of the reported results.

The overall performance evaluation of the 51 reported laboratories showed that 64% was acceptable, 15% was not acceptable, 5% was warning, and 16% was not reported.

The radionuclides requiring chemical processing of the sample are more difficult to handle. This is demonstrated by a relatively wide range of reported results. Thus, the laboratories should pay attention to the analytical work, and the provider should share information about the sample to improve results.

The issues that need improvement in the QC program are related to:

- The correction of the true coincidence summing effects for the determination of the cascade gamma emitting radionuclides
- The determination of the low energy gamma-emitting radionuclides.

Another issue is related to the radon-radium equilibrium in the sample, which deals with the sample preparation

Table 3: Training and workshops

Years	Workshop/training course	ALMERA	NLAR
2007	Understanding and evaluating radioanalytical measurement uncertainty. Trieste, Italy, 8-16 November 2007	61	3
2009	Uptake of radionuclides into staple crops in the Asian region. Daejeon, Korea, 16-17 April 2009	17	0
	<i>In situ</i> X-ray fluorescence and gamma ray spectrometry. Trieste, Italy, 26-30 October 2009	44	7
2010	Coincidence summing and geometry corrections in gamma spectrometry. IAEA-Vienna, Austria, 19-23 July 2010	32	2
2011	Measurement of natural radionuclides in environmental samples and NORMs and TENORMs by gamma spectrometry: Experimental challenges and methodologies. IAEA-Monaco, 5-9 December 2011	35	3
2012	Alpha spectrometry and radioanalytical techniques. Pretoria, South Africa, 15-19 October 2012	12	0
	Measurement results uncertainty and method validation. TAEK, Antalya, Turkey, 12-16 November 2012	29	1
2014	Rapid assessment methods for environmental radioactivity. Argonne National Laboratory, Argonne, United States of America, 10-21 March 2014	24	2
	Rapid determination of radiostrontium in milk. Korea Institute of Nuclear Safety, Daejeon, Republic of Korea, 3-7 November 2014	12	1
2015	Rapid assessment methods for environmental radioactivity. Argonne National Laboratory, Argonne, United States of America, 4-15 May 2015	24	0
	<i>In-situ</i> gamma-ray spectrometry. Spiez Laboratory, Spiez, Switzerland, 2-6 November 2015	24	0
2016	Determination of Organically Bound Tritium in Food Samples. Canadian Nuclear Safety Commission, Ottawa, Canada, 26-30 September 2016	14	4
2017	Measurement of natural radionuclides in environmental and NORM samples. KIT, Karlsruhe, Germany, 3-7 July 2017	24	0
2018	Determination of Characteristic limits Used in Nuclear Analytical Techniques. NPL, London, United Kingdom, 29-31 October 2018	30	2
Total attendance		362	25

TAEK: Turkish Atomic Energy Authority, KIT: Karlsruhe Institute of Technology, NPL: National Physical Laboratory, IAEA: International Atomic Energy Agency, ALMERA: Analytical Laboratories for the Measurement of Environmental Radioactivity, NLAR: North and Latin America region

and the usage of appropriate (radon tight) sample holder, especially if the radon exhalation of the sample is high.

Similar to the test 1, the NLAR scores are indicated in parentheses in Table 1b. The performance of the reported results is low to average, and the percentage of not reported results is very high. This could be due to the limited capacity and capability of the major member laboratories at that time. Over the last recent years, the increase of the membership and the number of reported results showed significant performance improvement.

Procedures

Tested and validated analytical procedures are important tools for the production of reliable, comparable, and “fit for purpose” analytical measurements. However, finding and choosing a procedure can be a challenge due to a wide variety of technologies available and the rapidity of developments in the field. Table 2 reports the most recent set of procedures for determination of radionuclides in environmental samples, both for routine environmental monitoring and emergency monitoring. The methodology used for development and validation of the ALMERA analytical procedures follows the IAEA publication procedure.^[12]

These procedures cover the determination of a large number of radionuclides from natural and anthropogenic

origin in a wide range of environmental matrices. They are published as IAEA documents and are available online on the IAEA website as a service to the international community.^[6] These documents are also made available to laboratories wishing to use procedures that have been validated by a large number of laboratories and therefore could be regarded as having been widely tested. NLAR showed a great interest in the techniques to their specific routine and emergency analysis.^[13,14] Most of the laboratories in the region are either already using these procedures or are looking for the means to develop them.

Training and workshops

The IAEA workshops and training (TW) courses aim at giving the opportunity to scientists from the ALMERA analytical laboratories to refresh and update their knowledge and skills in areas of interest to members of the ALMERA network. The TW consists of combination of lectures and practical exercises. The TW courses organized over the decade are listed in Table 3.^[7] According to this table, 14 ALMERA training sessions were carried out through combinations of theory and practical exercises in different radioanalytical techniques. The training sessions were conducted in 2 phases: the first was on the basics, including good laboratory practice, safety, quality systems, record keeping, basic laboratory techniques, and manual testing methods. The second phase included instrument operations, maintenance, troubleshooting, and documentation. In addition, training sessions were also conducted to specifically address deficiencies identified during assessments and to introduce instrumentation and quality assurance (QA). Table 3 shows that 362 member laboratories have been trained, including 25 from NLAR. These trained personnel, in turn, transfer and implement knowledge and good practices, respectively.

This was highlighted through the surveys and annual reporting.^[13,14] The NLAR participation is satisfactory regardless limited financial support. In the future, the NLAR participation would increase through the implementation of the IAEA technical cooperation activities.

Coordination meetings

The annual coordination meetings of the ALMERA network take place on rotation in different countries within regional network groups. These events aim at assessing the current

Table 4: Coordination meetings

Years	Location	ALMERA	NLAR
1997	IAEA, Vienna	38	4
2005	ICTP, Trieste, Italy	45	1
2006	KINS, Daejeon, Republic of Korea	36	2
2007	ICTP, Trieste, Italy	61	3
2008	CNEN-IRD, Rio de Janeiro, Brazil	27	8
2009	Food and Feed Safety Directorate, Budapest, Hungary	51	2
2010	ERPA, Addis-Ababa, Ethiopia	60	1
2011	IAEA, Vienna	79	7
2012	TAEK, Ankara, Turkey	46	4
2013	CNSC, Ottawa, Canada	35	6
2014	IAEA, Vienna	84	5
2015	IAEA Environment Laboratories, Monaco	61	7
2016	ANSTO, Sydney, Australia	50	4
2017	SSM, Stockholm, Sweden	74	7
2018	JAEC, Amman, Jordan	66	9
Total attendance		813	70

TAEK: Turkish Atomic Energy Authority, IAEA: International Atomic Energy Agency, CNSC: Canadian Nuclear Safety Commission, ALMERA: Analytical Laboratories for the Measurement of Environmental Radioactivity, NLAR: North and Latin America region

Table 5: Analysis outcomes

Strengths	Weaknesses
Good understanding of needs and priorities	Lack of funds/resources
Strong commitment to the collaboration	Shortage of expertise and equipment at new and/or basic laboratories
Good interaction and communication	Informal mechanisms of knowledge transfer
High level of capacity building in some laboratories	Limited participation to the ALMERA events

ALMERA: Analytical Laboratories for the Measurement of Environmental Radioactivity

status of the ALMERA network and at defining the future activities of the network. The annual coordination meetings with associated hosting locations are listed in Table 4.^[8]

The meetings review the implementation of the ALMERA activities and define a work plan for the future development of the network's activities.^[15]

The 15 coordination meetings took place at different locations in the member states. The attendance at each meeting ranged from 27 to 84 participants, representing 17–50 different laboratories. The meetings were attended by 70 participants from North and Latin America region, representing 8.6% of the total ALMERA participation (813).

The NLAR attendance is low to medium. Similar to the observation in the training component, attendance would improve through the implementation of the technical cooperation activities.

The meetings outcomes are compiled in the meeting minutes that are drafted by the central coordinator for all ALMERA members, and the regional coordinator drafts the summary for NLAR.^[15] Both are circulated to the regional members for information and consideration. The implementation of the work plan is monitored by the regional coordinator, which in turn, consolidates a regional report to the central coordinator and regional laboratory members.^[14]

Perspectives: NLAR coordination initiatives

The analysis and results of the survey questionnaires, in terms of strengths and weaknesses, of the regional capacity and capability are summarized in Table 5.

Overall (strengths), the regional laboratory infrastructure ranged from advanced (experienced) to basic capacities and/or capabilities. Furthermore, challenges (weaknesses) were identified in responding to the routine and/or emergency needs nationally and regionally. These include lack of resources in the region, capabilities, and competency in new and/or basic laboratories. To overcome these challenges and take the chance of opportunities, improvement initiatives are being developed.

Collaboration and networking initiatives

Collaboration and networking under NLAR are intended to strengthen the analytical capability of the region and to complement ALMERA core activities. This will be achieved by the establishment of the following collaborative activities that result in IAEA support, sharing of expertise, experience, and analytical capacities and capabilities.

International Atomic Energy Agency technical cooperation

The NLAR region designed a regional project on *strengthening quality management and networking in radio analytical laboratories in Latin America and the Caribbean*. The project aims to support the development of radio analytical capacity and its application to significant national and regional problems, by developing harmonized capacity and capability in the radio analytical measurements according to ISO/IEC 17025 international standard.^[16] The specific needs include (1) quality-assured radioanalytical measurements according to international quality standards, (2) capacity for monitoring and analysis of radionuclides for routine/emergency situations and naturally occurring radioactive material (NORM) industry impacts, (3) other applications of radioanalytical techniques to food, agriculture, and industries, (4) reinforcing regional collaboration and networking for sharing experiences, practices, and expertise and harmonizing regional analytical methodologies. As a result of the project, full upgrading and strengthening of competency and capability in measuring environmental radioactivity at both national and regional levels is expected to be achieved.

Mentorship program

Laboratory-mentoring program is an important vehicle to the new and/or basic laboratories to bring them to the average level in the region. This will focus on the implementation of existing and harmonized ALMERA good laboratory practices and enable scientists to acquire capacity and facilitate the transfer of knowledge from the advanced countries to the countries where the expertise is needed. The development of this program will include well-defined goals, standardized approach across laboratories, and measurement of progress, reporting mechanism and selection of trained mentors. These elements will differ in application, depending on laboratories' needs and available resources. The lessons learned and achieved results in this program, including challenges; best practices and recommendations will be used for improvement and possible extension to the advanced laboratories, if required.

Thematic groups

The thematic group(s) (TGs) can be defined as group of experts able to provide expert services to the region for which the NLAR/ALMERA support may be sought within the context of designated groups. The overall objectives are (a) foster collaboration when conducting new activities within the region; (b) enhancing regional self-reliance; and (c) acting as a body of knowledge in the field, to disseminate innovation and improved practices within the

laboratories in the region. This initiative is intended to support the implementation of the regional project work plan, to respond to regional needs and priorities in different areas. The TGs will focus on, for example, evaluation and management of NORM wastes; QA and QC; radiometric analysis (as required). More TGs and subspecific areas can be added to respond to other needs of the NLAR laboratory members. The impact in the region will be monitored and considered for further improvement initiatives and perspectives.

CONCLUSIONS

The key concluding remarks from experiences and perspectives of ALMERA in the NLAR are summarized as follows:

- ALMERA core activities helped the NLAR region to gain knowledge, implement harmonized laboratory practices, and improve QA/QC practices
- Regional coordination with assistance of member laboratories taking ownership of the regional program design, planning, implementation and monitoring using regional needs, priorities and challenges
- Cooperation project will strengthen radio analytical capabilities and promote cooperation among the countries for measurement of radionuclides in NORM, environmental and other samples types
- Collaboration will help build a network of expertise among laboratories, sharing of information and knowledge transfer, and upgrade capacity in the basic and emerging laboratories
- PT exercises provided the possibility for the members to quantify their levels of analytical performance and a step forward in the improvement of the comparability of results among the network members in the analyses of radionuclides.

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Conflicts of interest

There are no conflicts of interest.

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