	REGIONAL COOPERATIVE AGREEMENT **INTERNATIONAL ATOMIC ENERGY AGENCY**	

RCA Regional Programme Framework

2024-2029

Adopted at the 43rd RCA NRM

held in April 2021

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Dr. Prinath Dias (Chair)
RCA Programme Advisory Committee
February 2021

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THE OBJECTIVE OF THE RCA REGIONAL PROGRAMME FRAMEWORK

The objective of the RPF is to assist RCA stakeholders in drafting project proposals in areas of high priority for RCA GPs, taking into consideration the achievements and outcomes of previous RCA projects and criteria for RCA Technical Cooperative projects.

The RPF is to be used as a guideline and does not preclude submission of proposals that will address new needs and opportunities that may arise in the future. However, all project proposals will be reviewed by the RCA Programme Advisory Committee to ensure their alignment with RCA strategies and policies and should be approved at a meeting of the RCA National Representatives prior to being accepted for implementation as an RCA Technical Cooperative project.

All RCA stakeholders responsible for drafting project proposals should be provided with a copy of the RPF by the respective RCA National Representatives. It will also be possible to download it from the RCARO web-site.

RCA REGIONAL PROGRAME FRAMEWORK FOR 2024-2029

Introduction

Since its establishment in 1972 under the auspices of the International Atomic Energy Agency (IAEA) the RCA (The Regional Cooperative Agreement for Research, Development and Training) has significantly contributed to the socio-economic development of its Government Parties (GPs) through the use of nuclear technologies, mainly in the agricultural, environmental, human health, energy and industrial sectors. This has been made possible through the technical support provided by the IAEA through its Technical Cooperation Programme to RCA GPs for acquiring and applying well established nuclear technologies; the provision of human, physical and financial resources by RCA GPs for utilization of these technologies; and the cooperation among the RCA GPs.

The success of the RCA Programme is also because of the sound management structure RCA GPs have developed. All RCA policy issues, strategies, operational procedures and specific projects implemented under the RCA programme are decided by the representatives of the RCA GPs at their annual meetings. The RCA National Representatives also have the responsibility of managing and coordinating the implementation of the RCA Programme within their countries. Relevant policy issues, operational procedures and responsibilities of all RCA stakeholders are contained in the RCA Guidelines and Operating Rules (GOR).

RCA GPs have adopted a Medium Term Strategy which is updated every six years. The Medium Term Strategy contains the RCA Vision and Mission, its Core Values, Strategic Directions, and implementation enablers. The Medium Term Strategy is prepared by a Working Group (MTS Drafting WG) appointed by the RCA National Representatives. A Working Group on Medium Term Strategy Coordination (MTSC WG) also has been appointed to monitor the implementation of the Medium Term Strategy. RCA GPs also have appointed a Programme Advisory Committee (PAC) to advise and assist the RCA GPs on the different aspects of the RCA programme, namely development, implementation and evaluation of the projects.

The projects implemented under the RCA Programme are based on strategic priorities identified by the RCA GPs for the ensuing six-year period. The projects also need to conform to the criteria specified in the RCA Guidelines and Operating Rules and the RCA Strategic Directions. (see page 5)

The first effort to identify the RCA strategic priorities was made in 2010 for the period of 2012-2017, with the approval of RCA National Representatives, based on a recommendation of the IAEA Standing Advisory Group on Technical Assistance and Cooperation (SAGTAC). The strategic priorities were identified by groups of regional experts appointed for each RCA Thematic Sector, based on a survey conducted among the RCA GPs to determine regional priorities. Each expert group was chaired and guided by a RCA National Representative. The strategic priorities for 2018-2023 were identified by the Working Group on Medium Term Strategy based on a survey conducted among RCA GPs.

The General Conference Meeting of the RCA National Representatives held virtually in September 2020, requested the RCA PAC to develop a Regional Programme Framework containing the strategic priorities

for 2024-2029 in consultation with regional experts and the WG drafting the RCA MTS 2024-2029, and to present it to the 43rd RCA National Representatives Meeting in 2021.

Procedure for development of the RCA Regional Programme Framework for 2024-2029

An online survey was conducted by the RCA PAC to identify the priorities, current status and the future needs of the RCA GPs, in each of the RCA Thematic Sectors. Twenty RCA GPs out of 22 responded to the survey. The RCA PAC analyzed the outcomes of the survey to identify the overall priorities and the needs of the RCA GPs. A summary of the outcomes of the survey is given in Annex 2 and the detailed report can be found at http://rcaro.org/rpf/view/id/22712

RCA PAC also reviewed all the RCA projects implemented since 2007 (six TC cycles) and summarized the implemented activities, the outcomes and the achievements of these projects. A summary of the report is given in Annex 3 and the detailed report can be found at http://rcaro.org/projectsummary/view/id/22682

Expert Groups were formed in each Thematic Sector, comprising members of RCA PAC with expertise in the relevant areas, regional experts, and IAEA Technical Officers, and Chaired by a RCA National Representative. The WG on MTS was invited to participate as members of the expert groups. The composition of the Expert Groups is given on pages iii and iv. Expert Groups met through virtual platforms and provided their recommendations on priority areas, which formed the basis for the Regional Programme Framework. The reports containing the outcomes of the survey and the details of the previous RCA projects were provided to the expert groups, well in advance of the Expert Group Meetings.

The draft prepared by the expert groups was circulated to all the RCA National Representatives and to the WG on MTS and revised based on the feedback received. The procedure and the timeframe for the development of the RPF are given in Annex1.

Recommended Priority Areas

The Overall Prioritizations of the Project Areas recommended for 2024-29 are given in Table 1 and the areas not recommended are given in Table 2.

Agricultural Sector (3 priority areas)

The Expert Group for Agriculture recommended Food Safety (Overall priority 6), Plant Breeding (Overall priority 9) and Food Irradiation (Overall priority 12) as priority areas in Agriculture for 2024-2029.

Pest Control (Overall priority 10) was not recommended as a priority area in view of the extensive support provided to the RCA GPs through non-RCA projects. (Nine Regional Projects including two projects currently under implementation). Both Food Irradiation and Soil Fertility were ranked 12 in the overall priority order and the Expert Group recommended Food Irradiation over Soil Fertility since a large number of RCA GPs (over 60%) do not have national programmes on Soil Fertility.

Soil Erosion and Contamination (Overall Priority 15), Animal Health and Nutrition (Overall Priority 22) and Animal Reproduction (Overall Priority 24) were also not recommended.

Environmental Sector (3 priority areas)

The Expert Group recommended Water Resources Management (Overall Priority 4), Air-Pollution Monitoring (Overall Priority 8) and Management of Marine and Coastal Environment (Overall Priority 10) as priority areas for 2024-29.

Dam Safety (Overall Priority 24) was not recommended as a priority area.

Human Health Sector (3 priority areas)

The Expert Group recommended Radiation Oncology (Overall Priority 1), Medical Physics (Overall Priority 2) and Nuclear Medicine (Overall Priority 3) as priority areas for 2024-29.

Radioimmunoassay (Overall Priority 18), Nutrition (Overall Priority 20) and Tissue Grafting (Overall Priority 26) were not recommended as priority areas.

Industrial Sector (2 priority areas)

The Expert Group recommended Non-Destructive Testing (Overall Priority 6) and Radiation Processing (Overall Priority 16) as priority areas for 2024-29.

Nuclear tracers and sealed sources (Overall Priority 19) and Nuclear Gauges and NCS (Overall Priority 23) were not recommended as priority areas.

Other Areas (2 priority areas)

The Expert Group recommended Radiation Protection (Overall Priority 5) and Energy Planning (Overall Priority 12) as priority areas for 2024-29.

Research Reactor Utilization (Overall Priority 17) and Nuclear Instrumentation (Overall Priority 20) were not recommended as priority areas.

Table 1 – Recommended Project Areas

Priority Order	Project Area	Thematic Sector	Weighted Average
1	Radiation Oncology	Human Health	4.85
2	Medical Physics	Human Health	4.80
3	Nuclear Medicine	Human Health	4.75
4	Water Resources Management	Environment	4.40
5	Radiation Protection	Other areas	4.30
6	Food Safety	Agriculture	4.20
6	Non-destructive Testing	Industry	4.20
8	Air Pollution Monitoring	Environment	4.15

Priority Order	Project Area	Thematic Sector	Weighted Average
9	Plant Breeding	Agriculture	4.00
10	Marine and Coastal Environment	Environment	3.80
12	Food Irradiation	Agriculture	3.75
12	Energy Planning	Other areas	3.75
16	Radiation Processing	Industry	3.60

Table 2 –Project Areas Not Recommended

Priority Order	Project Area	Thematic Sector	Weighted Average
10	Pest Control	Agriculture	3.80
12	Land use - Soil fertility	Agriculture	3.75
15	Land Use - Soil Erosion and Contamination	Agriculture	3.65
17	Research Reactor Utilization	Other areas	3.55
18	Radioimmunoassay (RIA)	Human Health	3.45
19	Nuclear tracers and sealed sources	Industry	3.25
20	Nutrition	Human Health	3.15
20	Nuclear Instrumentation	Other areas	3.15
22	Animal Health and Nutrition	Agriculture	3.10
23	Nuclear Gauges and NCS	Industry	3.05
24	Animal Reproduction	Agriculture	3.00
24	Dam Safety	Environment	2.85
26	Tissue grafting	Human Health	2.45

Criteria for RCA and TC projects

Criteria for RCA Projects

A RCA project should:

(a) Address a significant multi-country issue;
(b) Address an issue identified as a regional priority;
(c) Be accepted as a part of national programmes with strong Government support;
(d) Have strong support and continuous involvement from end users;
(e) Have an appropriate and significant number of identified potential beneficiaries and partnerships;
(f) Be of sufficient size and duration to enable the identified significant outcomes to be achieved;
(g) Be implemented by a team that has high expertise and commitment; and
(h) Be well-managed

(RCA Guideline's and Operating Rules – Part 4, Section 1.1.3)

Central Criterion for IAEA TC Projects

All IAEA technical cooperation projects must meet a central criterion that demonstrates strong government commitment to project objectives, as outlined in the 2002 Review of the TC Strategy (GOV/INF/2002/8/Mod.1). A project must either:

- relate clearly to an area that is a prerequisite for use of nuclear technologies and that has a good chance of achieving the expected outcomes: or,
- address an area where there is a national programme enjoying strong government commitment with evidence of significant financial support, and where nuclear techniques can play a fundamental role for the success of the project

If a government supports a national programme to solve a development problem, then it is one that the government considers to be a national priority. And, if a government partners with the Agency to contribute to solving that problem by applying a nuclear technique, this is a good indication that the nuclear technique has a comparative advantage, or is crucial to the solution of the problem.

(Central criterion | IAEA)

IAEA Technical Cooperation Strategy

Objective and Outcomes related to Central Criterion

Objective

To produce sustainable benefits within the framework of national development plans.

Outcomes:

- A TC programme that is linked to national development plans and, where relevant, to the efforts of other donors working in the same area.
- Strong government commitment for the TC programme in Member States, and for the institutions managing it.
- Increased capacity in Member States through continued provision of the support needed to ensure the transfer of safe and secure applications of nuclear technologies, in keeping with priorities set by Member States.

(GOV/INF/2002/8/Mod.1)

RCA Strategic Directions (for 2018-2023):

i) **Strategic Direction 1:** To further enhance the operational management capacity of the RCA;

ii) **Strategic Direction 2:** To continue enhancing the sustainable contribution of the RCA towards meeting the developmental needs, priorities and interests of the RCA region;

iii) **Strategic Direction 3:** To ensure full integration of the RCA programme into the national development plans of RCA GPs and align with the SDGs at the regional level, as appropriate to the applications of NS&T;

iv) **Strategic Direction 4:** To reinforce and consolidate a culture of nuclear safety and security at regional and national levels, while promoting peaceful uses of NS&T for socio-economic development;

v) **Strategic Direction 5:** To continue building human capacity, including education and training and nuclear knowledge management, and accord particular attention to special needs of: (1) the new RCA GPs, (2) the Least Developed Countries (LDCs) and (3) the Small Island Developing States (SIDSs), to enable them to maximize their benefits from participation in the RCA programme;

vi) **Strategic Direction 6:** To promote self-reliance, good institutional governance and excellence in management amongst the RCA NNIs; and

vii) **Strategic Direction 7:** To enhance the general awareness about RCA's regional footprint and underpin resource mobilization efforts.

Priority Areas for 2024-2029

THEMATIC SECTOR – Agriculture

Introduction

The world population is predicted to increase to 8.5 billion by 2030 from the current 7.8 billion, resulting in the need to increase agricultural productivity for meeting the increased demand for food to feed the increasing population. The changing global climate requires better adaptation of crops and livestock to extreme and unpredictable climate conditions. These activities need to be performed in an environmentally sustainable manner, to prevent depletion of resources and to prevent leaving a detrimental legacy to future generations. There is increased emphasis on global trade, food safety, food security, and increasing the shelf life of food products. Currently, about one third of all food produced is wasted either somewhere in its path to the consumer or by the consumer.

Since the establishment of the RCA, many problems in the agricultural sector have been effectively addressed using nuclear technologies. Some of these technologies have reached considerable levels of maturity. In addition, a range of new and complementary technologies (e.g. ion beam irradiation; compound-specific isotope analyses; high-throughput analyses), as well as more efficient applications of the mature technologies, have the potential to make a significant contribution to addressing new challenges identified in the above key strategic areas.

Priority Area 1 – Food Safety (A1)

Access to sufficient amounts of safe and nutritious food is the key to sustaining life and promoting good health. Unsafe food containing harmful bacteria, viruses, parasites or chemical substances, causes more than 200 diseases, ranging from diarrhea to cancers. An estimated 600 million people – almost 1 in 10 in the world – fall ill after eating contaminated food, and 420 000 die every year, resulting in the loss of 33 million healthy life years (DALYs). US$110 billion is lost each year in productivity and medical expenses resulting from unsafe food consumption in low- and middle-income countries. Children under 5 years of age carry 40% of the foodborne disease burden, with 125 000 deaths every year. Diarrheal diseases are the most common illnesses resulting from the consumption of contaminated food, causing 550 million people globally to fall ill and 230 000 deaths every year. Food safety, nutrition and food security are inextricably linked. Unsafe food creates a vicious cycle of disease and malnutrition, particularly affecting infants, young children, the elderly and the sick. Foodborne diseases impede socioeconomic development by straining health care systems, and harming national economies, tourism and trade. (Source: World Health Organization Food safety (who.int)).

Outcomes of the Survey

7 GPs out of 20 responders to the survey indicated Food Safety to be an area of very high priority and 10 GPs an area of high priority. The overall priority order was 6, out of 26 project areas.

12 GPs indicated the existence of a national programme, 11 availability of human resources, 11 availability of infrastructure, 12 availability of protocols etc., 11 the existence of a professional body / national society, and 11 the involvement of end user. 13 GPs indicated the need for human resources development, 9 the need for laboratory services, 9 the development of protocols etc, and 7 the need for expert assistance.

Previous RCA Projects

The only RCA project on Food Safety, the objective of which is to improve food safety by establishing a robust and independent means of verification of origin of foodstuffs, is currently under implementation.

Future Directions

- Establishing the means of verification of origin of foodstuffs should continue to be a priority.
- Development of the analytical capability to use well-established nuclear and related techniques to detect food adulterants, chemical contaminants including veterinary drugs, pesticides, natural toxins, microbial contaminants and radionuclides, is also recommended as a priority area for 2024-29.
- Analytical ability to verify the presence/absence of food contaminants according to international standards in foods of animal origin and other food products exported from RCA GPs would be necessary to meet the requirements of the importers of these products. Accreditation of laboratories established for this purpose is also recommended as a priority area. Inter-comparison exercises carried out among RCA GPs would facilitate this task.

Expected Impact

RCA GPs will establish modern analytical capacity using nuclear/isotopic and complementary analytical techniques to ensure national food safety and international trade.

Opportunities for TCDC

Since this a new area for most RCA GPs, the opportunities for TCDC would be limited.

Links to SDGs

The project area will contribute to SDG Goal 2 – 'End hunger, achieve food security and improved nutrition, and promote sustainable agriculture'.

SDG 2 has five individual targets and the proposed future directions will address Target 2.1 (end –hunger and ensure access to safe food) and Target 2.2 (end malnutrition)

Priority Area 2 – Plant Breeding (A2)

Mutation breeding techniques have played a very significant role in addressing world food and nutritional security problems by developing new mutant germplasm and mutant varieties. By the end of 2019 induced mutations have made significant contributions in development and release of more than 3300 mutant varieties in more than 200 crop species by more than 70 countries in the world. 2010 mutant varieties,

which accounts for more than 60 % of the total mutant varieties in the world, have been released or approved for cultivation in the Asian and Pacific region.

Outcomes of the Survey

6 GPs out of 20 responders to the survey indicated Plant Breeding to be an area of very high priority and 9 GPs an area of high priority. The overall priority order was 9 out of 26 project areas.

13 GPs indicated the existence of a national programme, 15 availability of human resources, 13 availability of infrastructure, 12 availability of protocols etc., 12 the existence of a professional body / national society, and 10 the involvement of end user. 13 GPs indicated the need for human resources development, 9 the need for laboratory services, 4 the development of protocols etc, and 5 the need for expert assistance.

Previous RCA Projects

Five RCA regional projects on Plant Breeding have been implemented since 2007 including a project currently under implementation, in areas of improving crop quality and stress tolerance for sustainable crop production, development of new crop varieties adaptable to climate change, development of bioenergy crops to optimize marginal land productivity, and development of green enhancing crop productivity and quality crop varieties.

As a result of the regional projects on plant breeding, the RCA GPs have developed the capability of using radiation-induced mutation breeding technology to develop new varieties of crops. A very large number of new mutants have been developed by RCA GPs. Some of them have been released to farmers and others are undergoing trials before being released. These include new varieties of barley, wheat, sorghum, rice, mung bean, papaya, soybean, and legumes. A mutation breeding network for Asia and the Pacific has been created and a website established to facilitate exchange of information. (www.plantmutagenesis.net)

Mutant varieties released under the support of previous RCA projects have played important roles in enhancing global food security and contributing to SDG Goal 2. For example, a wheat mutant variety *Luyuan 502* released in China, with 11% higher yield than the traditional variety and also more tolerant to drought and the main diseases, has been planted over 3.6 million hectares and solved the practical problem of heavy lodging encountered during the cultivation of wheat varieties with heavy spikes. With a yield potential of more than 12 t/ha, it had been planted over more than 5.13 million hectares by 2019 and is now the second largest cultivated wheat variety in China, providing significant social and economic benefits. (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for details).

Future Directions

- The exploration and application of new mutagens in crop breeding through techniques such as heavy ion beams need to be strengthened in the RCA GPs, and collaborations between national institutes need to be enhanced to develop new elite mutants and varieties in crops.
- Validation of new mutation techniques established in more crop genotypes and species such as herb plants and underused crops.
- Genomics-enhancing mutant utilization - genetic evaluation; gene mapping; and characterization of selected best mutants with key green traits.

- High-throughput approaches on phenotypic screening of induced mutants, necessary to improve the efficiency. The mutants related to yield, quality, biotic and abiotic resistance need to be identified in large populations.
- Demonstration and dissemination of the released mutant varieties with integrated practice packages.
- The need to strengthen collaboration between institutes that are engaged in mutation breeding and the extension services responsible for transferring the techniques to farmers was also suggested as a need.
- Enhanced food security and accelerated seed industry through regional collaboration and promoting the application of mutation techniques to plant improvement.

Expected Impact

RCA GPs will establish a highly efficient breeding technology platform for the development and dissemination of new mutant varieties through a combination of nuclear technology and modern crop biotechnology to ensure national food security.

Opportunities for TCDC

Opportunities for training and technical support to developing GPs could be provided through RTCs and expert missions. New mutagens, protocols and approaches to mutant screening could be shared as resources within developing GPs.

Links to SDGs

The project area will contribute to SDG Goal 2 – 'End hunger, achieve food security and improved nutrition, and promote sustainable agriculture'.

SDG 2 has five individual targets and the proposed future directions will address Targets 2.1 (end –hunger), 2.2 (end malnutrition), 2.3 (double agricultural productivity), 2.4 (ensure sustainable food production) and 2.5 (maintain genetic diversity of seeds).

Priority Area 3 – Food Irradiation (A3)

Post-harvest food losses due to damage by insects, rodents, bacteria and mould, or from sprouting or over-ripening of produce, are estimated to be between 25 and 40% in many countries. Irradiation is an effective and safe method for preserving food as it reduces spoilage, improves food hygiene, and extends shelf life. Irradiation is also an effective method for quarantine treatment, thus significantly facilitating regional and international trade.

Sanitary applications for food irradiation are mature and very promising but commercial uptake in the Asia Pacific region has so far been relatively slow. However, the phasing out of chemical treatment of food will limit the available technologies that can be used which can be expected to increase the importance of food irradiation as a treatment method. There is also scope for work in special cases, e.g. food for hospital patients who have compromised immune systems.

Outcomes of the Survey

4 GPs out of 20 responders to the survey indicated Food Irradiation to be an area of very high priority and 10 GPs an area of high priority. The overall priority order was 12 out of 26 project areas.

12 GPs indicated the existence of a national programme, 10 availability of human resources, 10 availability of infrastructure, 10 availability of protocols etc, 6 the existence of a professional body / national society, and 10 the involvement of end users. 11 GPs indicated the need for human resources development, 8 the need for laboratory services, 8 the development of protocols etc, and 6 the need for expert assistance.

Previous RCA Projects

Five RCA regional projects on Food Irradiation have been implemented since 2007, including a project currently under implementation, introducing electron beam and X-ray technologies; introducing phytosanitary or quarantine treatment protocols of irradiation technology in encouraging greater intraregional trade; enhancing trade in irradiated products of economic importance; and strengthening adaptive climate change strategies for food security through food irradiation.

As a result of RCA regional projects on food irradiation, participating RCA GPs have adopted harmonized regulations to approve the irradiation of foods and phytosanitary regulations or protocols; adopted new food irradiation technologies; drafted guidelines for auditing and accreditation of irradiation facilities used for sanitary and phytosanitary treatment of food and agricultural products; amended quarantine regulations to include irradiation as a phytosanitary measure; and several GPs have successfully negotiated with new trading partners for commercial exports of irradiated commodities.

Future Directions

- The introduction of compact EB and X-ray units that can be installed in food processing plants.

  These plants, however, have a limited power output and are mostly suitable for removal of surface contamination only. This will contribute to the prevention of the spread of viral diseases, including Covid-19, through food contamination. Some countries are already using this technology as a measure against Covid-19. Food irradiation regulations may have to be revised to allow the use of compact EB and X-ray facilities.

- Prevention and control of harmful substances in foods by irradiation technology.

  Harmful substances such as allergens, mycotoxins and viruses in food (including Covid-19, contaminating frozen foods) are becoming serious food safety problems in the region. Researchers have demonstrated the degradation effects of harmful substances through techniques such as γ - ray, electron beam or X-ray irradiation. It is necessary to evaluate the potential applications and develop and integrate the related regulations through regional collaboration, in order to expand the application of irradiation technology in the field of processing and storage of agricultural products.

- Continuing consumer education of food irradiation using modern media platforms.

  Consumer acceptance and labeling requirements of irradiated foods are always two main obstacles in the commercial use of food irradiation technology. In the digital age, progress on labelling and

irradiated foods should be introduced to the food industry through communication materials developed for the different types of media platforms, which would also provide an opportunity for consumer education.

Expected Impact

RCA GPs will enhance the value of agricultural products and the effective prevention and control of harmful substances in foods by irradiation technology.

Opportunities for TCDC

New RCA GPs have given a high priority to Food Irradiation. Since most RCA GPs have developed expertise in these areas as a result of previous RCA projects, there would be opportunities to provide support for the new GPs through TCDC.

Links to SDGs

The project area will contribute to SDG Goal 2 – 'End hunger, achieve food security and improved nutrition, and promote sustainable agriculture'.

SDG 2 has five individual targets and the proposed future directions will address Targets 2.1 (end –hunger), and 2.2 (end malnutrition).

Opportunities for TCDC in the Agricultural Sector

New RCA GPs have given a high priority to Animal Health and Animal Reproduction. Since most RCA GPs have developed expertise in these areas as a result of previous RCA projects, there would be opportunities to provide support for the new GPs through TCDC.

Additional project areas suggested by GPs

- Smart agriculture and Green House Gas (GHG) emissions reductions
- Fishery resources management
- Holistic cyclo-farming system in which agriculture and livestock become a closed system in utilizing natural resources in a sustainable manner
- Developing modern, Digital Soil Information Systems (DSIS) and remote sensing harmonization through nuclear techniques

THEMATIC SECTOR – Environment

Introduction

About 3.5 billion out of the world population of 8 billion in 2020 live in the developing world in the Far East and South Asia. The growth in the population has paralleled with increasing standards of living in the developing world and correlates with increasing demands for natural resources such as water, energy, food, and living space, thereby putting increasing pressure on the environment to cope with human activities. Environmental pollution is generally a consequence of these activities. If unabated, the environmental impacts may be catastrophic for the present as well as for future generations.

The RCA has contributed to the global effort of environmental protection through regional cooperation in research and development, technology transfer, and training using nuclear science and technology. Projects in the areas of air pollution, fresh water resources, and marine and coastal pollution have been the focus of regional cooperation programmes.

Since 2007, 6 regional projects in marine and coastal pollution, 6 projects on management of water resources and 3 projects on monitoring of air-pollution have been implemented under the RCA Programme.

The survey conducted among RCA GPs indicated Water Resource Management (overall priority order 4), Air-Pollution Monitoring (overall priority order 8) and the management of the Marine and Coastal Environment (overall priority order 10) as high priority areas.

Priority Area 1 - Water Resources Management (EN1)

Water is essential for sustainable development, economic growth, and poverty reduction. In addition to meeting basic services related to water, inclusive economic growth itself must be supported by meeting the needs of centers of priority growth and production for water supply, sewerage, sanitation, irrigation and flood management. Efficient and effective management of water resources, including the development of new sources of water, is fundamental to achieving the desired inclusive economic growth while ensuring a sustainable environment. Obtaining reliable, impartial, timely information that is needed to understand water resources will be the drivers for the actions/response, remedies, and investments in the region in this particular area. Such understanding should enable governments to minimize the loss of life and property as a result of water-related natural hazards, such as floods, droughts and land movement; effectively manage ground and surface water resources for domestic, agricultural, commercial, industrial, recreational and ecological uses; protect and enhance water resources for human and aquatic health and environmental quality; and contribute to prudent physical and economic development of the area's resources for the benefit of present and future generations, The need for improved water resources information and water management tools and techniques to deal with a changing climate will therefore be the key challenges for the GPs to deal with in the future.

Outcomes of the Survey

10 GPs out of 20 responders to the survey indicated Water Resources Management to be an area of very high priority and 8 GPs of a high priority. The overall priority order was 4 out of 26 project areas.

15 GPs indicted the existence of a national programme, 13 availability of human resources, 12 availability of infrastructure, 9 availability of protocols etc, 10 the existence of a professional body / national society and 14 the involvement of end user. 13 GPs indicated the need for human resources development, 10 the need for laboratory services, 9 the development of protocols etc, and 8 the need for expert assistance.

Previous RCA Projects

RCA regional projects on Water Resources Management have been implemented since 1999 in areas of freshwater quality and groundwater contamination (3); management of ground water resources, including recharge of deep groundwater (6 projects); water resources in geothermal areas (1); and dam safety and sustainability (1). Another project on quality of groundwater resources is ongoing, to be completed in 2023. Three new projects on the mitigation of contamination of water resources by agro-contaminants; on improvement of water management practices to overcome effects of climate change; and on optimizing water usage in agriculture under drought conditions, are due to be implemented in 2022/23.

As a result of the previous RCA projects, RCA GPs have developed the capability of using isotope and geochemical techniques to investigate surface water-groundwater interactions and contaminant transport; using isotope techniques to investigate groundwater dynamics and recharge rates; and using nuclear techniques to monitor water quality. Novel groundwater dating techniques such as ^{3}H-He and Kr-81 have been introduced and may be availed by GPs with support from the IAEA. There is a high level of end user involvement in most of the RCA GPs that participated in these projects (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for details).

Future Directions

With industrialization, and with population growth and climate change being inevitable and impacting most countries within the region, finding ways and means to sustainably support freshwater demand i.e. managing what is exploitable, has to be the focus of future regional projects on water resources management.

For a comprehensive water resources assessment, the gaps in hydrological understanding can be grouped into three major categories: water supply; protection of water supply; and water production, development, and use. The remedies and further investments where the application of nuclear techniques could be advantageous are proposed:

A. Water supply

1. For surface water - The need to increase understanding of stream flow, surface water storage, and the effect of extreme weather and climatic events
2. For groundwater- The need to understand the quantity and flow of available groundwater and the effect of extreme weather and climate on the groundwater storage and flow
3. On water budget and global climate change

- The need to have an advanced level of understanding of the spatial and temporal distribution of precipitation and of extreme events for early warning and forecasting and risk assessment
- The need to understand run-off and recharge processes, origin of recharge, and residence time of groundwater. While the previous projects have dealt with these areas of study, quantitative methodologies still have to be more widely studied and applied.
- The need to understand evapotranspiration in sufficient detail to support water resources assessments and management needs.
- Surface and groundwater interaction – the need to better understand the interaction of surface water and groundwater in order to develop a unified understanding of the entire water budget at various scales to support IWRM (Integrated Water Resources Management)

B. Protection of water supply

1. Surface water and groundwater quality
    - The need to understand the current and potential vulnerability of water supplies to pollution (natural and anthropogenic)
    - The need to identify the source of pollution and quantify the contribution of each pollutant source for better management and mitigation (Environmental forensics)
2. Wastewater management - Explore the benefit of radiation technologies in wastewater management.

Expected Impact

The capability to understand and predict the movement and availability of water within all components of the hydrological cycle and to be able to simulate the impacts of various landscape changes on the distribution and availability of water will provide for fully effective water management within the region. This will enable governments to minimize the loss of life and property as a result of water-related natural hazards; effectively manage ground-and surface-water resources for domestic, agricultural, commercial, industrial, recreational and ecological uses; protect and enhance water resources for human and aquatic health and environmental quality; and contribute to wise physical and economic development of the region's resources for the benefit of present and future generations.

Opportunities for TCDC

As mentioned above, most GPs have developed the capability of using isotope and geochemical techniques in addressing hydrological problems in previous projects. TCDC has been practiced previously, such as Pakistan and China providing analytical services to GPs without the capabilities for isotopic analysis, as well as the provision of expert services. With newcomer GPs, TCDC can be practiced to a wider extent.

Links to SDGs

The project area will contribute to SDG Goal 6 - Ensure availability and sustainable management of water and sanitation for all.

SDG 6 has 8 target areas and the proposed future directions will address Targets 6.1 (ensure availability and sustainable management of water and sanitation for all), 6.3 (improve water quality), 6.4 (increase water use-efficiency) and 6.5 (implement integrated water resources management)

Priority Area 2 – Monitoring Air-Pollution (EN2)

Pollution caused by airborne particulate matter (APM) in many urban areas has become worse due to economic activities, rapid population growth, urbanization, and industrialization. Air pollution in one region can impact other adjoining regions by the fine particulate matter traveling across borders (transboundary pollution). Therefore, RCA projects need a collaborative approach to minimize the air pollution problem in the region. Air pollution is now being recognized as a regional problem with a serious impact on human health. Research-based knowledge is needed on the specific pollutants responsible for the adverse health effects; the correlation between fine particulate matter and human health; environmental risk assessment; as well as the impact on climate change due to short-lived climate-forced pollutants (SLCP). Utilization of the database developed by air pollution monitoring projects will help assess the health impact, and the environmental risk, as well as provide a better understanding of the impact of climate change. It is envisaged to extend and enhance the sustainability of local air particulate matter monitoring by carefully considering the needs of the GPs regarding pollution management in urban regions; human health orientated end user; capacity of human resources development; and phasing in new end users. The RCA programme of air particulate matter research is needed to expand and emphasize the capabilities related to nuclear analytic techniques in the many Asian cities in the RCA region, especially in the environmental sector. Understanding the source of air pollutants, local and regional, and its impact will provide valuable information to environmental managers, stakeholders, and end users.

Outcomes of the Survey

8 GPs out of 20 responders to the survey indicated Monitoring Air-Pollution to be an area of very high priority and 9 GPs an area of high priority. The overall priority order was 8 out of 26 project areas.

13 GPs indicted the existence of a national programme, 12 availability of human resources, 13 availability of infrastructure, 11 availability of protocols etc, 9 the existence of a professional body / national society, and 14 the involvement of end user. 13 GPs indicated the need for human resources development, 10 the need for laboratory services, 6 the development of protocols etc, and 7 the need for expert assistance.

Previous RCA Projects

Three RCA regional projects on air-pollution monitoring have been implemented since 2007 in the areas of characterization and source identification of particulate air pollution, and on assessing the impact of particulate matter on urban air quality. RCA GPs also participated in a research project on “Air Quality and Environmental Impact Assessment of Industrial Activities in Asian Region” supported by the RCA Regional Office.

As a result of the previous RCA projects on monitoring air-pollution, RCA GPs have developed the capability of using nuclear techniques (XRF, IBA and NAA) to monitor air-pollution, to carry out source identification and apportionment analysis, and to carry out long-range transport analysis. The world-first elemental and source fingerprint databases have been completed and published. A very high usage rate of the databases from 37 end user (overall 88 stakeholder engagements) in RCA countries has demonstrated the relevance of the data in policy decision-making processes and has shown the advantages of the application of nuclear analytical techniques in the environmental sector and success in collaborating with several end user within the Ministry of Environment in each GP. (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

- Air pollution monitoring was identified as a very high priority and high priority area by 17 GPs, indicating the need for further study to support the national demands in each GP to provide monitoring data of air pollution and identify the pollutant sources in tackling the air pollution problem.
- Most RCA GPs who participated in previous RCA and non-RCA projects have been able to develop their infrastructure. Some GPs have established human resources and facilities, but some GPs need greater human resources development and laboratory services. Several new GPs are interested in being involved in air pollution projects and this will provide an opportunity to expand and yield better networking among the RCA GPs and to introduce the utilization of NATs to the new GPs. Some GPs, including new GPs, need further support to develop their human resources and infrastructure.
- There is also a need to improve collaboration among the technical services providers of the RCA GPs. The technical services and human resources developments required could be enhanced through better cooperation in sharing expertise, harmonizing protocols, and providing access to established facilities amongst the participating GPs.
- Improving capabilities of RCA GPs in the monitoring of air pollution including organic pollutants and the application of data utilization for risk assessment (hazard identification, dose-response assessment, exposure assessment, and risk characterization), as well as health impact assessment, would be a step closer to fulfilling the current needs in environmental studies. Understanding the correlation between climate change and short-lived climate-forcing pollutants (SLCP), such as black carbon, is also an important issue at the national and global level. Improved SLCP emission inventories and measurement methodologies are also necessary to enhance scientific understanding and assessment of their role in climate change as well as to inform climate policy. Through the utilization of nuclear analytical techniques, information on the chemical composition of airborne particulate matter including organic pollutants for source apportionment and identification of the sources that contribute to the hazards and to SLCP emissions will be possible and will play a significant role in better understanding the risks, health impacts and climate change effects of particulate pollution.

Expected Impact: Reduction of the levels of air-pollution and its effects on human health and on the environment of the RCA GPs.

Opportunities for TCDC

The RCA has new GPs (Cambodia, Nepal, Fiji, Laos, and Palau) who need more extensive support to join this project area. They participated in a workshop on Supporting Operational Procedures and Developing Capability for New Participating GPs to expand regional cooperation in 2016. Through participation in this workshop, Nepal has been involved and shown high interest in joining RCA projects on this topic, while the others need an intensive approach and technical assistance to be able to participate in projects.

There are opportunities for other developing RCA GPs to provide expertise to assist the new GPs to develop their human resources, infrastructure, and laboratory services. Providing support for new RCA GPs to develop their infrastructure and human resources through TCDC is recommended as a priority for 2024-2029.

Another priority area for 2024-2029 is expanding the project on air pollution monitoring by initiating a study of the impacts of air pollution on human health. The linkage of air pollution measurements to health impacts by correlation with health data in each country showing impact of exposure to particles will be an important outcome of the project. To support the effort to reduce air pollution, long term and continuing measurements need to be carried out including the development of monitoring parameters for organic pollutants. Policy makers in each GP will obtain the benefit of air pollution monitoring linked with the health impact assessments. A reduction in adverse health events will be a key indicator of the level of achievement of the goals of the imposed mitigation measures.

Links to SDGs

The project area will contribute to SDG Goal 3 - Ensure healthy lives and promote well-being for all at all ages: Goal 11 - Make cities and human settlements inclusive, safe, resilient and sustainable: and Goal 13 - Take urgent action to combat climate change and its impacts

The proposed future directions will address SDG target 3.9 (substantial reduction of health impacts from hazardous substances) and SDG target 11.6 (reduction of adverse impacts of cities on people). In particular, efforts to combat air pollution will, inter alia, contribute to SDG target 7.2 on access to clean energy in the home, SDG target 11.2 on access to sustainable transport and SDG 13 (climate action), as well as the goals of the Paris Agreement on Climate Change, especially on the SLCP (Short-Lived Climate Pollutants) issue.

Priority Area 3 – Marine and Coastal Pollution Monitoring (EN3)

For the world's coastal areas — where the majority of the world's population lives — the health, well-being, and, in some cases, the very survival of people depend upon the preservation and protection of marine and coastal systems, including their estuaries, wetlands, watersheds, drainage basins, and near-shore coastal waters. The Asia and Pacific, in particular, is home to the "Coral Triangle", a region that is recognized as the global centre of marine biodiversity and a global priority for conservation. Therefore, it is imperative to manage and protect marine and coastal landscapes and ecosystems. Interventions made today will determine the sustainability of marine resources and their ecological services both now and in the future.

Outcomes of the Survey

8 GPs out of 20 responders to the survey indicated Marine and Coastal Pollution to be an area of very high priority and 6 GPs an area of a high priority. The overall priority order was 10 out of 26 project areas.

13 GPs indicated the existence of a national programme, 12 GPs the availability of human resources, 12 GPs the availability of infrastructure, 9 GPs the availability of protocols, guidelines, and standards, 7 GPs the existence of a professional body or national society, and 12 GPs the involvement of end user. 12 GPs indicated the need for human resources development, 9 GPs for laboratory services, 8 GPs the development of protocols, guidelines, and standards, and 5 GPs the need for expert assistance.

Previous RCA Projects

Six RCA regional projects on the marine and coastal environment have been implemented since 2007 in the areas of assessing the radiological impact of nuclear power activities on the marine environment; harmonization of nuclear and isotopic techniques for marine pollution management; marine benchmark study on the possible impact of the Fukushima radioactive releases in the Asia-Pacific Region; assessment of climate change for sustainable marine ecosystem management; enhancing regional capabilities for marine radioactivity monitoring; and assessing the vulnerability of coastal landscapes and ecosystems to sea-level rise and climate change.

As a result of previous RCA projects in the Marine and Coastal priority area, QMS Guidelines for Monitoring the Impacts of Nuclear Activities in the Marine Environment have been prepared and adopted by the RCA GPs - seven GPs have acquired QMS accreditation, formulated environmental protection policies and environmental quality guidelines, and developed strategic plans for future environmental monitoring; collaborations have been established with end users; ASPAMARD database has been revived and updated; it has been determined that there was no impact from Fukushima accident releases in territorial waters of GPs beyond Japan; and new marine radiochemistry and/or radioecology laboratory facilities have been established in 12 GPs. Moreover, applications of nuclear and isotopic techniques to the transport and fate of land-based pollution sources, and understanding the impact of climate change in the marine ecosystem, have been prepared and harmonized. The list of techniques used includes U-series, Pb-210, Ra-226, Po-210, Cs-137, C-14, and XRF, among others. (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

From the outcomes of past projects, future directions that can be explored include the following:

- Marine radioactivity measurement and impact assessment
    - Through the increased capabilities of the GPs, harmonized methods for marine radioactivity measurement and risk assessment, and the vast databases produced by past RCA projects, marine radioactivity data can be used as a powerful oceanographic tracer to understand natural coastal and marine processes better. Examples of such include ocean circulation and water mass mixing, with particular focus on understanding areas of complex oceanography such as the South China Sea, Indonesian Through-flow, etc.

- Coastal and marine pollution and associated issues
    - A holistic and comprehensive, “ridge-to-reef” approach to pollutant assessment and management using nuclear and isotopic data through:
        - Assessment and historical reconstruction of various pollutants, such as plastics, heavy metals, sedimentation and siltation, among others. Particular focus is on emerging marine and coastal pollutants, such as plastic pollution.
        - Integrating large databases of nuclear and isotopic data from environmental forensics to determine pollution sources and their specific contributions to marine and coastal environments. Examples include fingerprinting and apportionment of possible sources of pollution (e.g. land uses and specific anthropogenic activities), and using computational techniques, multivariate statistics, and/or machine learning to determine source contributions to the overall pollution in coastal areas. This information can help environmental managers focus on sources with the highest contributions to overall pollution.
        - Integrating nuclear and isotopic observation data into various modelling techniques (e.g. sediment transport modelling), mainly to validate the models to understand marine and coastal pollutant transport and fate from the source to the sea. Through this, effective mitigation measures can also be devised.
- Understanding climate change and its impacts on marine and coastal environments
    - Reconstruction of historical climate change and its impact on marine and coastal environments using nuclear and isotopic techniques, such as XRF, XRD, XCT, stable isotopes, and radiometric dating. Particular focus is suggested for past marine conditions (e.g. temperature, pH), catastrophic events (e.g. tsunamis, volcanic eruptions, extinction events), climate-change-related issues (e.g. ocean acidification, sea-level rise), and understanding their impacts to marine and coastal ecosystems.

Expected impact: Improvement of the management of the coastal and marine resources and reduction of coastal and marine pollution in RCA GPs

Opportunities for TCDC

TCDC opportunities include human resource development, laboratory sharing, and protocol/guideline/standards development for harmonization and capacity-building of the relevant nuclear and isotopic techniques, data analysis, associated modeling methods, interpretation, and impact assessment of the technological priorities outlined above.

In addition, there is a significant opportunity to develop the laboratory and infrastructure capabilities of developing countries through technical cooperation projects, especially as developing countries are the ones most dependent on the ecosystems of the marine and coastal environments.

Links to SDGs

The project area will contribute to SDG 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development: and SDG 13 - Take urgent action to combat climate change and its impacts.

SDG 14 has 7 target areas and the proposed future directions will address Targets 14.1 (significantly reduce marine pollution of all kinds), and 14.2 (sustainably manage and protect marine and coastal ecosystems).

SDG 13 has 5 target areas and the proposed future directions will address Target 13.1 (adaptive capacity to climate-related hazards and natural disasters)

Additional project areas suggested by GPs

- Water resources management: integrated water governance
- Conserving and preserving cultural heritage
- Climate change
- Environmental forensics using nuclear techniques
- Inland ecosystem management – lakes and rivers
- Geothermal energy
- Radioactive contamination of ground water (due to mining operations and nuclear waste disposal)

THEMATIC SECTOR – Human Health

Based on the previously implemented RCA projects in Human Health Sectors, six project areas in Human Health sector were analyzed in the survey for RCA NRs to determine the priority areas for implementation in the 2024-2029 project cycles. The weighted averages calculated from the levels of priorities assigned by the GPs were as following (very high priority = 5 and very low priority = 1): Radiation Oncology 4.85, Medical Physics 4.80, Nuclear Medicine 4.75, Radioimmunoassay (RIA) 3.45, Nutrition 3.15, and Tissue Grafting 2.45. The average scores indicate that Radiation Oncology was ranked as the first and Medical Physics and Nuclear Medicine ranked as the second and third priorities respectively in the Human Health Sector. In fact, these three priority, Radiation Oncology, Medical Physics, and Nuclear Medicine, were the three highest-ranked areas in all the thematic sectors combined, demonstrating that the RCA GPs are placing the highest priority in the Human Health Sector represented by these three priority areas. The priorities of the RCA GPs have been represented in the RCA Human Health projects implemented during 2007-2019, in which no projects have been implemented in the fields of Radioimmunoassay, Nutrition, and Tissue Grafting.

According to the results of the survey in Human Health sectors, with additional analysis of the RCA projects implemented during 2007-2019, the Working Group has identified the three highest-ranked project areas of Radiation Oncology, Medical Physics and Nuclear Medicine to be suitable for the priority areas for RCA in the 2024-2029 project cycles.

Priority Area 1 – Radiation Oncology (HH1)

Introduction

Cancer is a major health burden in the RCA region and is projected to increase significantly over the coming decades as life expectancy improves, communicable diseases are controlled, and health transition occurs. Radiation therapy (RT, also called radiotherapy) remains one of the three pillars of cancer treatment, along with surgery and systemic therapy (chemotherapy). RT provides an exceptional use of nuclear technology for human benefit. RT is used in the curative treatment of cancers, with the aim to eradicate the cancer permanently, or for palliation, to relieve distressing symptoms of cancer when cure is not possible.

For the curative treatment of cancer with RT, higher radiation doses lead to an improved chance of cure. However, higher radiation doses also cause a greater chance of adverse effects and complications, which can limit the dose that can be delivered to the cancer. As a result, there have been constant efforts to improve the technology to increase the dose to the cancer, while reducing the radiation dose to the surrounding normal tissue and organs that may cause complications.

As a result of the RCA projects implemented in the recent past, RCA GPs have acquired the capability of applying advanced radiation therapy techniques.

Outcomes of the Survey

17 GPs out of 20 responders to the survey indicated Radiation Oncology to be an area of very high priority and 3 GPs an area of high priority. The overall priority order was 1 out of 26 project areas.

16 GPs indicated the existence of a national programme, 13 availability of human resources, 16 availability of infrastructure, 17 availability of protocols etc, 15 the existence of a professional body / national society, and 13 the involvement of end user. 12 GPs indicated the need for human resources development, 6 the need for laboratory services, 11 the development of protocols etc, and 10 the need for expert assistance.

Previous RCA Projects

13 RCA regional projects on Radiation Oncology have been implemented since 2007, including two projects currently under implementation. Two new projects are planned for the 2022/23 cycle. These projects are in areas of high-precision 3D radiation therapy, image-based radiation therapy, 3D image-guided brachytherapy, stereotactic body radiation therapy, radionuclide therapy, intensity modulated radiation therapy, palliative radiation therapy, and hypofractionated radiation therapy.

As a result of these projects, a number of RCA GPs have developed the capability of using 3D Conformal Radiotherapy (3D CRT) and have established the required QA and QC procedures. Approximately 500 Radiation Oncologists, 300 Medical Physicists and 350 Radiation Therapy Technologists have been trained on 3D CRT under the RCA projects.

114 professionals have been trained on 3D Image-Guided Brachytherapy (IGBT) and 53 new institutes in RCA GPs have established IGBT. Stereotactic Body Radiotherapy (SBRT) has been established in 20 centres. A total of 110 Radiation Oncologists, Medical Physicists and Radiation Therapists have been trained on SBRT. The capability of using Intensity Modulated Radiation Therapy (IMRT) has been expanded and strengthened. An online training course on Applied Sciences of Oncology developed under two previous RCA projects have been further developed and made available for the use of all RCA GPs.

Formal relationships have been established between the RCA and national Radiation Oncology Associations in the region. Moreover, the regional radiation oncology society of the Federation of Asian Organizations for Radiation Oncology was founded based on the specialist network built through the activities of the RCA radiation oncology projects. In addition, strong cooperation with the Forum for Nuclear Cooperation in Asia (FNCA) in radiation therapy has been established.

(See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

The priorities for the RCA projects during 2024-2029 in the area of radiation oncology are as follows:

- Sustainable technical transfer of advanced RT technology for various cancers in our region through education and training in these fields (for example, the use of artificial intelligence (AI), Image-Guided Radiation Therapy (IGRT), Adaptive RT, altered-fractionation RT, particle beam RT (proton and heavy ions), combination RT with immunotherapy, RT for oligometastases, etc)
  Since the basic infrastructure and radiation oncology technology have been developed in most of the GPs in the RCA region through RCA projects in previous project cycles, and the infrastructure

of more advanced RO technology, for example particle beam RT, has been gradually developed in recent years in many RCA GPs, there is a need for projects of advanced technologies in the 2024-29 project cycle.

- Establishment of efficient and sustainable teaching of advanced radiation oncology for radiation oncologists (ROs), medical physicists (MPs), and radiation therapy technologists (RTTs).
  There is an ongoing need for the provision of efficient and sustainable education for radiation oncology professionals especially in the face of the continuous shortage of such professionals and the new challenge of the COVID-19 pandemic. The effective use of education materials, resources, and technologies such as IT, in cooperation with existing professional societies and the IAEA, should be explored in order to meet the need.

- Meeting the needs of newcomer GPs by transferring technology and educating personnel in the basics of radiotherapy in order to establish RT technology aligned with the infrastructure and health economic conditions of the new GPs.
  RCA collaboration in line with the principle of TCDC should be strengthened by possible participation of intermediate GPs as recipients. For island GPs in particular, strengthening distant education and communication systems in radiation oncology using IT may be considered for education, training, and clinical collaboration among RCA GPs.

- Improving the treatment capacity for specific clinical indications in line with the WHO target goals or other global/regional initiatives (e.g. cervical cancer - in line with the Global Strategy to Accelerate the Elimination of Cervical Cancer by WHO; and pediatric cancer - WHO Global Initiative for Childhood Cancer, etc.)

Expected impact: Reduction in the mortality and morbidity rates of cancer patients in RCA GPs

Opportunities for TCDC

In past RCA projects in the field of radiation oncology, the involvement of experts from GPs with developing country status has been significant. The institutions in developing GPs have been major hosts for meetings and regional training courses, and the experts from these GPs have been instrumental, not only in these regional events but also in various expert missions such as lecturers in national training courses and quality auditors. These practices of TCDC should be continued in the 2024-29 project cycles.

New opportunities of TCDC should be found in regard to priority 3 (Meeting the needs of newcomer GPs by developing basic capability of radiotherapy through RCA collaboration.). The developing GPs in RCA should have ample experience of introducing new centres and technologies of radiation therapy in their own countries, and these experiences should provide extremely valuable knowledge for the newcomer GPs. The participation of the intermediate GPs, possibly as “donor” status in the project, can become a new possibility of participation and collaboration in RCA projects.

Links to SDGs

The project area will contribute to SDG 3 - Ensure healthy lives and promote well-being for all at all ages.

SDG 3 has 7 target areas and the proposed future directions will address Targets 3.1 (reduce premature mortality from non-communicable diseases), and 3.4 (access to quality essential health-care services).

Priority Area 2 – Medical Physics (HH2)

Introduction

Medical physicists play an important role in the safe and effective practice of radiation medicine including radiotherapy, nuclear medicine and radiology. The IAEA describes the roles and responsibility of a clinically qualified medical physicist in equipment acceptance and commissioning, radiation safety, radiation dosimetry, optimization of procedures and quality management of equipment and processes. To undertake this level of responsibility, the medical physicist needs to undergo comprehensive education and training which according to the IAEA shall be inclusive of an undergraduate degree in a physical science (or equivalent), a postgraduate degree in medical physics, and at least two years training in a clinical setting (according to TCS 37, 47 and 50).

Clinically qualified medical physicists also play an important role, along with other health professionals in radiation medicine, in ensuring that new techniques and technologies are introduced safely and effectively in clinical practice. In this area, the role of continuing professional development of the medical physicist is vital.

Surveys of the medical physics workforce in the RCA region indicate current and future shortfalls in required numbers of clinically qualified medical physicists. A pathway for recruitment of medical physicists through education and training is vital to address the needs in radiation medicine and is best addressed through a regional approach.

Outcomes of the Survey

16 GPs out of 20 responders to the survey indicated Medical Physics to be an area of very high priority and 4 GPs an area of high priority. The overall priority order was 2 out of 26 project areas.

12 GPs indicated the existence of a national programme, 8 availability of human resources, 10 availability of infrastructure, 15 availability of protocols etc, 13 the existence of a professional body / national society and 12 the involvement of end user. 11 GPs indicated the need for human resources development, 5 the need for laboratory services, 11 the development of protocols etc, and 9 the need for expert assistance.

Previous RCA Projects

Three RCA regional projects in Medical Physics have been implemented since 2007 on education and training of Medical Physicists, including one project currently under implementation. A new project on "Improving the Quality and Safety of Radiotherapy in Asia Pacific Region through Medical Physicist Education & Training" is due to be implemented in the 2022/23 TC cycle.

The RCA project RAS 6038 developed three clinical guidelines, namely, "Clinical Training of Medical Physicists Specializing in Radiation Oncology (IAEA Training Course Series 37)", "Clinical Training of Medical Physicists Specializing in Nuclear Medicine (IAEA Training Course Series 50)", and "Clinical Training of Medical Physicists Specializing in Diagnostic Radiology (IAEA Training Course Series 47)".

These guidelines have helped to initiate clinical training programs in IAEA Member States of all regions, develop confidence in the abilities of MPs, and supported stakeholders in the certification/registration of MPs.

Under RAS 6077, an e-learning platform (AMPLE - Advanced Medical Physics Learning Environment) for training Medical Physicists has been created on the IAEA's CLP4NET platform. Through this project guidelines on accreditation of educational institutions and clinical training facilities, and on certification of professionals in medical physics, have been developed. A survey was conducted and a gap analysis performed to determine the needs and resources for clinical practice in GPs. An editorial board has been established to support access to the latest training material provided through AMPLE.

Guidelines on postgraduate academic training of Medical Physicists also have been developed by the IAEA. (IAEA Training Course Series 56).

(See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

Medical physicists will continue to play a role in the expansion of access and development of radiation medicine practice in the RCA region. The following areas highlight future initiatives to strengthen the medical physics workforce in radiation medicine for the benefit of patients.

- Supporting access of GPs to education and training of medical physicists according to international best practice, sustaining an e-learning platform (AMPLE) and implementing relevant activities to increase the number of clinically qualified medical physicists in the RCA region, and strengthening the links between academic institutions and clinical institutions.
- Supporting the continuing professional development needs of practising medical physicists through providing updates in areas of medical physics practice with emphasis on relevant techniques and procedures, audit methodologies and relevant technologies.
- Forging alliances through the regional medical physics society AFOMP, and its associated sub-regional and national societies, to promote medical physics recognition within the region and disseminate standards of medical physics education, training, accreditation and certification.

Expected Impact: Improvement of the quality and safety of radiation medicine in RCA GPs.

Opportunities for TCDC

The widespread adoption of IAEA recommendations in medical physics education, training and practice in the RCA region, through the previous and ongoing support of the IAEA and RCA, means that many developing GPs are ready to act as resource in the field of medical physics. Thailand for example has developed self-sustaining programs for clinical training in radiotherapy, nuclear medicine and radiology and has already provided remote clinical supervision of medical physics trainees and examinations. Other developing GPs also have expertise and demonstrated leadership in the medical physics profession and can act as a resource in regional medical physics initiatives through hosting of RTCs, provision of experts,

clinical supervisors and examiners, and hosting of clinical training positions. Medical physics education and training lends itself to a regional cooperative approach because GPs with limited radiation medicine capacity struggle to achieve sustainable academic and clinical training programs in medical physics without the support of large neighboring GPs. TCDC has already been demonstrated in the area of medical physics education and training through fellowship programmes under national TC projects and in previous RCA projects RAS 6077 and RAS 6087.

Links to SDGs

The project area will contribute to SDG 3 - Ensure healthy lives and promote well-being for all at all ages.

SDG 3 has 7 target areas and the proposed future directions will address Targets 3.1 (reduce premature mortality from non-communicable diseases), and 3.4 (access to quality essential health-care services).

Priority Area 3 – Nuclear Medicine (HH3)

Introduction

Nuclear medicine is an important component of medical imaging, and the IAEA continues to support its development throughout the developing world and will continue to play a leading role in setting and maintaining standards of practice. The practice of nuclear medicine has changed dramatically, mainly owing to the extraordinary increase in the use of positron emission tomography (PET-CT), which has demonstrated the importance of molecular imaging in clinical practice; the introduction of multimodality imaging and its wide acceptance; and the introduction of newer therapeutic radiopharmaceuticals. Nuclear medicine provides diagnostic, prognostic, predictive, and intermediate endpoint biomarkers in oncology, cardiology, neurology, and infectious and inflammatory disorders. Whole-body target expression can be quantified and used for predicting therapy response. Treatment-induced metabolic changes serve as early prognosticators of therapy effectiveness. At the same time, technologic advances such as total-body and hybrid PET/MR imaging are revolutionizing the diagnostic capabilities of PET systems.

In the field of nuclear medicine, trace amounts of radiopharmaceuticals, which are pharmaceutical products containing radioactive atoms, are used for the diagnosis and treatment of many health conditions, such as certain types of cancer, neurological illnesses and cardiovascular diseases by performing: (i) molecular and functional diagnostic investigations, through the visualization, characterization and quantification of biological processes taking place at the cellular and subcellular levels in patients; and (ii) metabolic and immune targeted radiopharmaceutical treatments.

Nuclear medicine requires specific medical competences. Detailed strategic planning is particularly important in developing countries, where nuclear medicine may not be in optimal operations or currently be unavailable, and the benefits and complexities of nuclear medicine imaging and therapy may not be clearly appreciated.

Outcomes of the Survey

15 GPs out of 20 responders to the survey indicated Nuclear Medicine to be an area of very high priority and 5 GPs an area of high priority. The overall priority order was 3 out of 26 project areas.

12 GPs indicated the existence of a national programme, 10 availability of human resources, 10 availability of infrastructure, 10 availability of protocols etc, 10 the existence of a professional body / national society, and 10 the involvement of end user. 10 GPs indicated the need for human resources development, 9 the need for laboratory services, 7 the development of protocols etc, and 9 the need for expert assistance.

Previous RCA Projects

Seven RCA regional projects on Nuclear Medicine have been implemented since 2007, including one project currently under implementation. As a result of these projects, guidelines on establishing PET facilities and on clinical applications of PET have been prepared; a number of new Gamma Cameras, SPECT CTs and PET CTs have been installed in RCA GPs; Nuclear Medical professionals in RCA GPs have been trained using the IAEA distance learning platform DATOL; capacity of using radiology in terms of CT for diagnosis of cancer has been improved; a project platform established on the RCA website (http://www.rcaro.org/undp_s11) for information sharing and networking among experts; and a total of 2,774 NM Professionals have been trained and are networking in oncology, cardiology and neurology, representing an increase of 140%.

(See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

- Hybrid imaging and new technologies in image and instrumentation. Whole-body target expression can be quantified and used for predicting therapy response. Treatment-induced metabolic changes serve as early prognosticators of therapy effectiveness. At the same time, technologic advances such as total-body and hybrid PET/MR imaging are revolutionizing the diagnostic capabilities of PET systems.

- Enhancing Theranostics (combination of diagnosis and therapy) application in clinical practice. Theranostic principle applications applied to neuroblastoma, lymphomas, neuroendocrine tumors, paraganglioma, and prostate cancer. Specifically, technical support should be prioritized on the role of theranostics in neuroendocrine tumours and prostate cancer. Peptide receptor radionuclide therapy has become a major component in the management of unresectable or metastatic gastroenteropancreatic, bronchopulmonary, and other neuroendocrine tumors. Various kinds of radiopharmaceuticals are being developed for theranostic approaches for various kinds of cancers with promising results.

- Incorporating Nuclear Neurology in the management of dementia and related neurological disorders. In line with this predicted paradigm shift on how to diagnose neurodegenerative diseases, there is growing evidence that PET imaging will gain a larger role in the context of treatment stratification and therapy monitoring. PET imaging will be used as standard clinical care to elucidate underlying pathology with high sensitivity and many years before the first cognitive or motor symptoms occur. Focus will be on the use of amyloid imaging tracers flutemetamol, florbetapir, and florbetaben labelled with (18)F for PET imaging.

- Producing radioisotopes and synthesizing radiopharmaceuticals for newly emerging diagnostic and therapeutic application. Facilitating accessibility to qualified cyclotron and automatic module produced radiopharmaceuticals is important to enjoy the benefits of technical advances such as theranostic

approaches for cancers and diagnosis of neurodegenerative diseases. Setting and maintaining standards of practice and quality control for newly introduced radiopharmaceuticals will accelerate the use of new technologies in clinical practice.

Expected Impact: Improvement of diagnostic and therapeutic capabilities of RCA GPs using radioisotope based diagnostic and therapeutic techniques.

Opportunities for TCDC

The IAEA TCDC strategies complement the RCA's regional planning and build synergies between programmes at the regional and national levels, thereby contributing to the achievement of the United Nations' Sustainable Development Goals. Throughout the years, robust technology mobilization has empowered GPs in the field of Nuclear Medicine and Radiology. Regional projects have contributed towards updating protocols and guidelines relevant to hybrid imaging and therapeutics. As these technologies evolve, newly introduced radiopharmaceuticals, instrumentation and nuclear technologies continue to shape clinical practice and these can be opportunities for GPs to utilize TCDC mechanisms through training courses and workshops.

Links to SDGs

The project area will contribute to SDG 3 - Ensure healthy lives and promote well-being for all at all ages.

SDG 3 has 7 target areas and the proposed future directions will address Targets 3.1 (reduce premature mortality from non-communicable diseases), and 3.4 (access to quality essential health-care services)

<u>Additional project areas suggested by GPs</u>

- Nutrient requirement based on early life nutrition; impact evaluation of the first 1,000 days policy and program implementation
- Verification of Dietary Reference Intake (DRI) as a basis for food-based dietary guidelines; appraisal of nutrient quality and safety within the context of healthy and sustainable diet
- Accelerator development and utilization – Proton and Carbon Ion therapy technology including human resource development.
- Development of brachytherapy sources for cancer treatment
- Diagnostic radiology
- Myocardial perfusion imaging and dynamic PET/CT.

THEMATIC SECTOR – Industry

Introduction

The applications of nuclear technology in industry range from the design of components and systems, to quality control and assurance, plant lifetime extension, process evaluation and optimization, troubleshooting, industrial processing, manufacturing, production of new materials, and process control. These applications can largely be grouped into four, namely, (1) non-destructive evaluation and testing; (2) radiation processing; (3) radiotracer applications for industrial process troubleshooting and optimization; and (4) nucleonic control systems.

Industrial development is the cornerstone for socioeconomic growth and progress. The RCA has invested heavily in industrial projects in the past. These investments, especially in human capital, technology transfer, and overall upgrading of capacity and capability in nuclear technology, serve as a good platform for the applications of these technologies to move ahead. The capacity that has been developed has contributed to the overall growth in the region, which is experiencing rapid development.

A major focus of the RCA programme during the 1980s and 1990s was in the industrial sector. A number of RCA projects in all four areas mentioned above were implemented during this period, many of them with the support of the UNDP. Over the past two decades, the main focus of the RCA GPs has shifted from industry to human health.

The current priorities of the RCA GPs under this thematic area are in areas of non-destructive testing (NDT) and radiation processing. Radiotracer applications and nucleonic control systems are of a lower priority.

Priority Area 1 – Non-Destructive Testing (IN1)

Non-destructive testing using nuclear radiation is an important non-power application of nuclear technology that is widely used by industry for testing a variety of components for quality control, quality assurance, and monitoring of plant integrity during construction, operation, and maintenance. Major user industries of NDT such as power generation, manufacturing, and processing industries are governed by regulatory requirements for periodic plant shutdowns. NDT is one of the powerful tools to minimize these shutdowns resulting in huge economic saving to industry. The ability to carry out in-situ NDT inspections is a major advantage.

The use of NDT by the oil and petroleum industry in the region is a vindication of its usefulness and economic value in the operation and maintenance of complex industrial processes and plants. As interests on nuclear power programme in many countries in the region are developing, NDT is expected to play more and expanded role in the energy-related industry. New methods such as digital radiography that is becoming more and more common would necessitate the development of capability in that area as well as the establishment of new protocols.

The strategic sectors of transportation, energy, aviation, electronics, information technology and atomic energy have a major role to play as they are the forerunners for developing, adopting, and implementing the most recent and advanced technologies as well as modern concepts and philosophies such as Total

Quality Management (TQM). This conclusion originates from the fact that these sectors demand extremely rigid and stringent quality requirements.

Initiatives or broad-based program to strengthen expertise in NDT's science and technological aspects should be made to meet the growing regional needs. Concurrent to the industrial growth is the concomitant increase in the sophistication of technology used and hence the advancement in the NDT methods itself. The development of a strong base of indigenous capabilities suitable for specific applications is an approach that can catalyze future growth and progress. Immense opportunities exist to use this reservoir of expertise and experience to solve challenging problems and for achieving cost effective quality assurance and quality control requirements in small, medium, and large industries in the GPs.

Outcomes of the Survey

8 GPs out of 20 responders to the survey indicated Non-Destructive Testing to be an area of very high priority and 8 GPs an area of high priority. The overall priority order was 6 out of 26 project areas.

8 GPs indicted the existence of a national programme, 12 availability of human resources, 15 availability of infrastructure, 11 availability of protocols etc, 13 the existence of a professional body / national society and 15 the involvement of end user. 11 GPs indicated the need for human resources development, 9 the need for laboratory services, 10 the development of protocols etc, and 7 the need for expert assistance.

Previous RCA Projects

Five RCA regional projects on Non-Destructive Testing have been implemented since 2007, including one project currently under implementation. Another project is being planned for implementation in 2022/23. These projects are in areas of digital industrial radiography (DIR); establishment of quality management systems (QMS) in accordance with ISO standards; in situ applications in process and petrochemical industries; harmonization of non-destructive testing schemes; planar and volume imaging techniques; NDT of non-metallic materials; and NDT in Civil Engineering.

As a result of the previous RCA projects, RCA GPs have developed expertise and capabilities in using digital industrial radiography (DIR), and guidelines for training, examination and certification in DIR testing have been prepared and adopted. The RCA GPs have also developed the capability of using portable gamma tomography for in-situ applications in process and petro-chemical industries. There have been a very significant increase in the number of trained NDT personnel, and the number of companies providing NDT services, during this period of project implementation.

(See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

- The scope of future projects takes into consideration several factors including rapid progress in other technology that enables better NDT implementation: increasing use of new materials in industrial and building components: the gap in the capabilities of meeting NDT industrial needs in several GPs: and the new normal brought about by the pandemic.
- Continue to expand the focus of the project to include new advanced NDT techniques in complementing radiation based method and techniques. Future projects on NDT should also continue its effort in

producing qualified and certified personnel in advanced NDT techniques in accordance with internationally accepted standard (ISO 9712) through its regional training course. Having qualified and certified personnel through the project will provide participating GPs means to establish pools of Level 2 and Level 3 personnel to achieve sustainability and self-reliance of the technology at the national level.

- Proactively respond to the rapid changing inspection requirements and demands with the increase in introduction of new materials for industrial components. Additive manufacturing (3D printing) has found its way in various industries and will inevitably be the option in the future of components and parts manufacturing. This will present unique challenges to NDT to support this emerging technology for the QA and QC of its products and components. The increasing use of new materials in industrial and building components would be served by introducing NDT in manufacturing processes.
- There has been rapid progress in other areas of engineering such as the use of artificial intelligence (AI), machine learning (ML), and augmented and virtual reality (AR and VR), that spill over to other engineering pursuits which could be, and has been to a certain extent, exploited in the NDT area. Intelligence augmentation (IA) will also be the future in NDT practice, where it will enable NDT personnel to interface with NDT hardware, software and algorithms in performing specific tasks and provide assistance in inspection decision making.
- A new training approach using AR platform could be implemented. The use of AR in NDT training will enhance the mental and physical dexterity of students. AR gives the NDT trainee the opportunity to see, observe, and feel at the same time while learning. The practical aspect could be supplemented by VR technology that allows trainees to deal with real-inspection world situations beyond the perspective of theory. The development of training materials in these areas should be given attention to facilitate the virtual training/ workshop components of the project.
- Another scope is the development of integrated NDT inspection systems utilizing the Big Data approach for monitoring and assessing damage in critical engineering components, especially in the energy sector and in the oil and gas industry – (e.g. using AE+IR Thermography + MFL + UT C-Scan) for Crude Oil Storage Tank NDT-QMS).

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Expected Impact

RCA GPs will be able to develop indigenous capabilities in NDT in meeting industrial needs that would in turn support growth in areas such as the industrial, manufacturing, and processing sectors.

Opportunities for TCDC

There are opportunities to provide technical support to new RCA GPs for development of their NDT programmes by RCA GPs with well-established NDT programmes. The specific needs could be identified through expert missions.

Links to SDGs

The project area will contribute to SDG Goal 9 - Build resilient infrastructure, promote sustainable industrialization and foster innovation.

SDG 9 has 8 target areas and the proposed future directions will address Targets 9.2 (promote inclusive and sustainable industrialization: 9.3 (access of small-scale industrial and other enterprises): and 9.5 (upgrade the technological capabilities of industrial sectors).

Priority Area 2 – Radiation Processing (IN2)

Radiation processing, either by gamma or electron beam, has been widely used in many areas of the global economy. It has demonstrated to be a clean technology where no solvents, additives and cross linkers are added. Among the well-established technologies are sterilization, polymer crosslinking and grafting, tyre component curing, conservation of art objects, and irradiation of specific foods.

Previous RCA projects have covered the basics and various technological aspects related to radiation processing, while the project currently being planned will focus on the development of Quality Management Systems (QMS) to ensure that irradiated products fulfil industrial standards. This will open more opportunities in industry which directly contribute to the economy of each GP. This is in line with the application of this technology to crucial areas such as Food Safety (Food, Fruits and Herbs sterilization); Environmental Safety (treatment of liquid/solid waste such as animal waste/industrial waste); Plant Mutation Breeding (producing new crops); Producing New Functional Materials (Nano and Bio Materials modifications using radiation); Cultural Heritage (Preservation of manuscript/Conservation and consolidation of artefacts)

Outcomes of the Survey

4 GPs out of 20 responders to the survey indicated Radiation Processing to be an area of very high priority and 9 GPs an area of a high priority. The overall priority order was 16 out of 26 project areas.

7 GPs indicated the existence of a national programme, 7 availability of human resources, 10 availability of infrastructure, 9 availability of protocols etc, 5 the existence of a professional body / national society and 12 the involvement of end user. 10 GPs indicated the need for human resources development, 7 the need for laboratory services, 6 the development of protocols etc, and 5 the need for expert assistance.

Previous RCA Projects

Three RCA regional projects on radiation processing have been implemented since 2007 in the areas of applications for health and the environment; development of polymeric materials for agricultural applications and environmental remediation; and development of advanced grafted materials for industrial applications and environmental preservation. A new project on quality management of radiation processing facilities is being planned for implementation in 2022/23.

The following have been achieved as a result of the previous RCA projects on radiation processing:

Development of new products: Hydrogel wound dressing that can be used to treat a variety of clinical complications following burns; fish feedstock from irradiated oligo chitosan (a waste product); PVA based hydrogel (this technology has been transferred to a private company); plant growth promoters and plant

protectors (these products have been commercialized); super water absorbents (for irrigation); toxic metal absorbents; ion exchange membranes; evaporator membranes; catalysts and bioactive carriers.

New radiation processing facilities have been installed in a number of RCA GPs. (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

- The scope of future projects would be focused on minimizing the environmental effect of polymer waste products; preservation of artefacts of archaeological importance; and utilization of recycled polymers for building materials. All of these would be achieved by using radiation processing methods.
- The use of plastic is prevalent in most GPs. Environmental pollution due to plastic and other polymer waste products, including the pollution of the oceans, due to micro-plastics is an issue of major concern for many countries. Radiation processing can reduce the molecular weight of polymers, facilitating the recycling of waste polymer products.
- The ability of radiation processing to preserve artefacts of archaeological importance, by using radiation in the consolidation of wooden artefacts and fabrics, is included in the scope of projects. The ability of radiation for polymer cross-linking will be exploited to produce composite materials for building construction.
- In general, the focus in radiation processing is the use of radiation in reducing the environmental burden due to the use of polymers and the preservation of artefacts of importance. The environmental burden would be reduced by facilitating plastic recycling and by converting them into useful building materials.

Expected Impact

RCA GPs will be able to develop capabilities in radiation processing and using those capabilities in addressing environmental issues and in the preservation of important artefacts.

Opportunities for TCDC

There are opportunities for RCA GPs with well-established programmes to provide technical support to new RCA GPs in developing their capabilities. The specific needs could be identified through expert missions.

Links to SDGs

The project area will contribute to SDG Goal 9 - Build resilient infrastructure, promote sustainable industrialization and foster innovation.

SDG 9 has 8 target areas and the proposed future directions will address Targets 9.2 (promote inclusive and sustainable industrialization, and 9.5 (enhance scientific research, upgrade the technological capabilities of industrial sectors).

It will also address Target 11.4 (protect and safeguard the world's cultural and natural heritage)

OTHER AREAS

Priority Area 1 - Radiation Protection (RP1)

Introduction

Establishing and maintaining radiation protection regulatory and technical infrastructures that are commensurate with the applications of nuclear technologies in their countries are essential requirements for the IAEA Member States. The radiation protection infrastructures should ensure the safety of workers, the public, and the environment in the use of nuclear technologies and should comply with relevant requirements GSR Part 3, Radiation Protection and Safety of Radiation Sources International Basic Safety Standards. The IAEA is assisting its Member States to establish sound, adequate radiation protection infrastructures through national and regional Technical Cooperation projects and by other means.

The current status of radiation protection in the IAEA Member States is recorded in the database RASIMS (Radiation Safety Information Management System) (recently migrated to RASIMS 2 and enables Member States to assess how closely their infrastructures for radiation safety are aligned with IAEA Safety Standards' recommendations and requirements. The information provided by the Member States is recorded according to different Thematic Safety Areas (TSAs), namely, Regulatory Infrastructure for Radiation Safety (TSA 1), Occupational Radiation Protection (TSA 2), Radiation Protection in Medical Exposure (TSA 3), Public and Environmental Radiation Protection (TSA 4), Education and Training in Radiation Protection and Safety (TSA 6), Transport Safety (TSA 7). Information about Emergency Preparedness and Response (TSA 5) is contained in EPRIMS (EPR Information Management System).

RCA GPs have received assistance through past RCA projects on Radiation Protection and through non-RCA regional projects. There is a wide variation of the levels of radiation protection infrastructures among the RCA GPs.

Outcomes of the survey on priorities and needs of the RCA GPs

12 GPs out of 20 responders to the survey indicated Radiation Protection to be an area of very high priority, and 5 GPs an area of high priority. The overall priority order was 5 out of 26 project areas. All 4 new RCA GPs that responded indicated Radiation Protection as an area of very high priority.

15 GPs indicated the existence of a national programme, 11 availability of human resources, 15 availability of infrastructure, 11 availability of protocols etc, 10 the existence of a professional body / national society, and 14 the involvement of end user. 13 GPs indicated the need for human resources development, 8 the need for laboratory services, 11 assistance in the development of protocols etc, and 6 the need for expert assistance.

Previous RCA and non–RCA Projects

Eight projects on Radiation Protection have been implemented in the past under the RCA programme, including a project on emergency response which is currently under implementation. Other projects were on strengthening radiation protection infrastructures in RCA GPs; harmonization of radiation protection practices; environmental radiation monitoring; assessment of radiological risks; radiological emergency response; and ensuring sustainability of radiation protection infrastructures of the RCA GPs. Until 2020,

there have been no RCA projects on radiation protection following the closure of the project on sustainability of radiation protection infrastructures in 2012. This was due to the extensive support provided to the RCA GPs through non-RCA regional projects.

Since 2007, there have been 40 non-RCA regional projects on Radiation Protection in all Thematic Safety Areas. The IAEA also supported a post graduate degree programme in Radiation Protection for the benefit of IAEA Member States in the Asia and Pacific Region. However, there has been a decline in the number of projects under more recent TC cycles and only three non-RCA regional projects on Radiation Protection have been implemented since 2018. In addition to the regional projects, RCA GPs also had received support for development of their radiation protection infrastructures through national projects. (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

The high priority given to Radiation Protection by the RCA GPs (overall priority 5 out of 26 areas) indicates there is a need for further support for development of radiation protection infrastructures of the RCA GPs.

Most RCA GPs who participated in previous RCA and non-RCA projects have been able to develop their regulatory infrastructure (TSA 1) and occupational exposure control capabilities (TSA 2) to meet the requirements of GSR Part 3 by taking into account the relevant recommendations formulated through Safety Guides, e.g., GSG-7, SSG-46. The others could be expected to develop these capabilities in the near future.

The future support for those GPs that now meet the requirements of GSR Part 3 for TSA 1 and TSA 2 should be in areas of Medical Exposure Control (TSA 3), Emergency Preparedness (TSA 5) and Public and Environmental Protection (TSA 4), given in that priority order. These GPs should be requested to carry out a self-assessment and develop road maps for meeting the requirements of GSR Part 3. Review missions and advisory services offered by the Agency would be helpful in this regard, particularly Advisory Mission on Regulatory Infrastructure for Radiation Safety (AMRAS), Integrated Regulatory Review Service (IRRS) and Occupational Radiation Protection Appraisal Service (ORPAS)

There is also a need to improve cooperation and collaboration among the technical services providers of the RCA GPs, through better networking. Cooperation with the Asia and the Pacific regional ALARA Network (ARAN) is essential to facilitate information, findings and data exchange and practical and cost-effective implementation of the principle of optimization of radiation protection in RCA countries. Technical services required for radiation protection programmes in the RCA GPs can be enhanced and strengthened through inter-comparison exercises which can be carried out in collaboration with the Asian Radiation Dosimetry Group (ARADOS). Accreditations of the laboratories of technical service providers as well as strengthening of radiation safety culture in the region are also areas to focus on. Accreditation of the laboratories of technical service providers is not required by the GSR Part 3 but recommended by GSG-7.

Duplication between RCA projects and non-RCA projects in Radiation Protection should be avoided through proper coordination.

Expected Impact

RCA GPs will establish radiation protection infrastructures commensurate with the applications of nuclear technologies in their countries in order to ensure the safe use of nuclear technologies.

Opportunities for TCDC

The five new GPs to the RCA need more extensive support for development of their radiation protection infrastructures. This was reflected in their response to the survey, where the highest priority was given to radiation safety. There are opportunities for other developing RCA GPs to provide expertise to assist the new GPs to develop their radiation protection infrastructures.

Providing support for the new RCA GPs to develop their regulatory infrastructure (TSA 1) and occupational exposure control (TSA 2) through TCDC are recommended as priority areas for 2024-2029. This was identified as a priority under the RCA Strategic Priorities for 2018-2023 as well.

Links to SDGs

This project area will contribute to SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

SDG 8 has 12 target areas and the proposed future directions will address Target 8.8 (promote safe and secure working environments for all workers).

Priority Area 2 – Energy Planning (EP2)

Introduction

Energy is essential for all human activities, and its availability is critical to economic and social development. It is vital to the provision of basic civic services in education, health care, clean water supply and sanitation, and also for wealth creation. Energy, especially electrical energy, is the engine for the production of goods and services across all economic sectors (Source: IAEA[1]). There is a strong co-relation between per capita consumption of electrical energy and per capita GDP.

Expansion of electrical power systems requires long lead times and therefore long-term planning is essential. This is a complex process that requires forecasting of future demand for electrical energy based on expected economic growth and identification of sources of energy to meet the expected demand based on economic and environmental factors. Energy generating equipment has a long lifetime, therefore present decisions on its use will have influence over the next 10, 20, 30 years, and longer periods, along with the associated obligations, therefore careful planning and multi-dimensional analysis is essential. Most countries prepare long term expansion plans with a planning horizon of 15-20 years, and these plans are updated at regular intervals.

The IAEA has prepared a number of planning tools to assist its Member States in energy planning. These tools cover various phases of energy planning process, from energy data collection topics and energy

[1] IAEA Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments, IAEA, Vienna, Austria, 2009

demand analysis to supply simulation and financial and environmental considerations. Below is a short description of each tool[2]:

- MAED (Model for Analysis of Energy Demand) – for evaluation of future energy demands based on medium- to long-term scenarios of socioeconomic, technological and demographic development
- ESST (Energy Scenario Simulation Tool) for the first step in energy demand-supply analysis and for identification of scenarios to be later elaborate with more details with other, more sophisticated tools. Also serves as an entry into energy planning issues for first time energy system analyst
- WASP (Wien Automatic System Planning Package) – a widely used model in developing countries for power system generation expansion planning
- FINPLAN –(Model for Financial Analysis of Electric Sector Expansion Plans) – for assessing the financial viability of plans and projects, taking into account different financial sources, including export credits, commercial loans, and bonds
- MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) - for mapping energy flows from supply (resource extraction) to demand (energy services). The tool helps in designing long term strategies by analyzing cost-optimal energy mixes, investment needs and other costs for new infrastructure, energy supply security, environmental pollution and energy resource utilization
- SIMPACTS (Simplified Approach for Estimating Impacts of Electricity Generation) – for estimating and quantifying the health and environmental impacts and external costs of different electricity generation technologies
- EBS (Energy Balance Studio) – Compilation of energy statistics and energy balances and associated trainings in this area
- EMPOWER (Extended Input Output Model for Sustainable Power Generation) – used to study macroeconomic effects of investments into energy projects, including nuclear energy and nuclear applications (for example radiopharmaceuticals and irradiation technologies)

The IAEA also offers various frameworks for energy system assessment:

- ISED (Indicators for Sustainable Energy Development) – indicators of interaction of energy with economy, environment, and society
- CLEW (Climate, Land, Energy and Water interactions) – the CLEW framework integrates assessment approaches and methodologies and facilitates collaboration among policy analysts and planners dealing with complex interactions and linkages between climate, land, energy, and water
- SEA[3] (Strategic Environmental Assessment) – a decision support framework for assisting the preparation of policies, plans and programmes that are environmentally sustainable and essential for the development of nuclear power

[2] More information on tools available at https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy/division-of-planning-information-and-knowledge-management/planning-and-economic-studies-section and through email contact PESS.Contact-Point@iaea.org

[3] SEA should not be confused with EIA (Environmental Impact Assessment). EIA is carried out at project level, while SEA applies at the program level

IAEA Members States have developed the capability of using these tools through training provided under the Technical Cooperation programme and other means.

Outcomes of the survey on priorities and needs of the RCA GPs

6 GPs out of 20 responders to the survey indicated Energy Planning to be an area of very high priority and 7 GPs an area of a high priority. The overall priority order was 12, out of 26 project areas.

10 GPs indicated the existence of a national programme, 7 availability of human resources, 7 availability of infrastructure, 6 availability of protocols etc, 7 the existence of a professional body/ national society, and 10 the involvement of end user. 11 GPs indicated the need for human resources development, 4 the need for laboratory services, 7 the development of protocols etc, and 6 the need for expert assistance.

Previous RCA Projects

Nine projects on energy planning have been implemented in the past under the RCA programme, in areas of energy and nuclear power planning; comparative assessment of energy planning options; the role of nuclear power and other energy options in mitigating green-house gas emissions; the role of nuclear power and other energy options in competitive electricity markets; and the formulation of sustainable energy development strategies in the context of climate change.

As a result of these projects, the RCA GPs have developed the capability of using the analytical tools developed by the IAEA to evaluate their energy options with regard to economics, environmental costs and benefits, as well as the overall impact on social and economic progress. They have also developed the capability of developing sustainable energy development strategies, making decisions on energy sector development and assessing the potential role of nuclear power and other energy options. These projects have assisted the RCA GPs to develop scenarios with respect to their energy plans and understand the level of environmental burden different energy options contribute. (See Annex 3 and http://rcaro.org/projectsummary/view/id/22682 for more details)

Future Directions

The last RCA project on energy planning (RAS 0045) was implemented during 2007-2008. The IAEA's tools in Energy Planning are constantly updated and there is a need for energy planners of the RCA GPs to be trained on these updated planning tools. The IAEA has also developed new planning tools such as the module for the Integrated Climate Land Energy Water Analysis, based on Sustainable Development Goals.

Many of the current energy planners in the RCA GPs have been trained through national training programmes and could benefit from regional training programmes conducted by experts in energy planning. There is also a need to provide training on energy planning in the context of increased use of renewable energy sources.

There are also opportunities for RCA GPs to benefit from the Regional Centre for Excellence of the IAEA, as well as the partnership between the IAEA and the World Bank, International Renewable Energy Agency (IRENA) and UN Department on Economic and Social Affairs (UN DESA) energy planning.

Expected Impact

RCA GPs will develop and implement optimal long-term expansion plans for meeting the energy requirements for economic development, while addressing climate change and other environmental issues.

Opportunities for TCDC

RCA has five new GPs who did not benefit from the previous projects on energy planning. There are opportunities for other developing RCA GPs with expertise and experience in energy planning to assist these countries to initiate energy planning programmes.

Links to SDGs

This project area will contribute to SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

SDG 7 has 5 target areas and the proposed future directions will address Target 7.1 (ensure universal access to affordable, reliable and modern energy services).

Additional project areas suggested by GPs

- Nuclear Power : SMR technology, public awareness and outreach
- Education and training in nuclear science
- Radiation protection, safety culture and waste management
- Research reactors and simulator training

Recommendations

1. The approved Regional Programme Framework (RPF) should be effectively used as a planning tool in the preparation of the RCA Programmes for implementation under the TC cycles of 2024/25, 2026/27 and 2028/29.
2. The RCA National Representatives of the RCA GPs submitting Pre-concepts for the respective TC cycles should ensure those who draft them have access to the RPF, and that the Pre-concepts are drafted with a good understanding of the identified regional priorities, outcomes of previous RCA projects, the criteria for RCA projects, and the RCA Strategic Directions (outlined in the Medium Term Strategy for the corresponding period).
3. The RPF should be used as a guideline by the RCA National Representatives in deciding on the RCA projects to be implemented.
4. The Pre-concepts and Project Concepts should be drafted in consultation with the relevant stakeholders of the other participating GPs and thereby duplication of Pre-concepts should be avoided.
5. The specific needs of new RCA GPs and GPs with a lower level of technological development should be addressed, either through separate projects designed for these GPs, or by having specific components in RCA projects aimed at the needs of these GPs. The possibility of establishing a mentoring mechanism between new GPs and more advanced GPs should be considered.
6. Since successful technology transfer requires a long period of time, long term planning is necessary to achieve socio-economic impacts. The RCA programme for a given TC cycle should be designed with due consideration of the projects implemented during the previous cycle and with an understanding of the projects to be implemented in the next cycle.
7. It is noted that regional TC projects in the same project area are implemented as both RCA and non-RCA projects. Duplication of efforts between the two programmes should be avoided through effective coordination between the IAEA TC Department and the RCA secretariat.
8. Action should be taken collectively by the RCA GPs to ensure the RCA Programme has sufficient financial resources by encouraging the IAEA to allocate a higher proportion of funds to the RCA Programme, and by encouraging RCA GPs to provide enhanced Extra Budgetary Contributions.
9. RCA GPs should make a concerted effort to establish partnerships with regional and international development agencies to undertake implementation of projects in areas of common priorities, and

in areas where nuclear technologies has advantages over other technologies. RCA GPs should consider establishing a managerial structure and procedures to make this possible.

10. The new normal brought about by the COVID-19 pandemic has necessitated, among others, the reduction of human contact and exposure. At the same time, it has been shown that existing and new technologies could be used for hybrid training - on-line for theoretical, and face-to-face for practical aspects through training/ workshops. While the pandemic may no longer be an issue during the intended period of this RPF (2024 - 2029), the practice of making use of virtual meetings should be continued and expanded to include virtual training.

Annex 1

Timeframe for Development of the Regional Programme Framework for 2024-29

	Item	Timeframe	Responsibility
1	Agreement on the Survey Form	12h October 2020	PAC Chair, in consultation with PAC members, RCA FP and WG on MTS
2	Survey to identify the priorities, current status and future needs of the RCA GPs	14th October – 20th November	National RCA Representatives, PAC
3	Compilation of the outcomes of the Survey	20th November – 7th December	PAC
4	Identification of External Experts, and IAEA Technical Officer and an NR (as Chair) for Expert Groups in each Thematic Area	20th November	PAC Chair in consultation with RCA FP and PAC members, WG on MTS
5	Formation of Expert Groups for each Thematic Area, comprising an NR (Chair), IAEA TOs, External Experts, and designated PAC Members*	31st November	PAC Chair, in consultation with PAC members, RCA FP
6	Circulation of the outcomes of the survey and information on past RCA Projects to the Expert Groups	10th December	PAC Chair
7	The Expert Group Meetings (virtual meetings) for preparation of Strategic Priorities for each Thematic Sector	10th -20th January 2021	PAC /RCA FP
8	Compilation of Expert Group Meeting recommendations and preparation of the Regional Programme Framework	20th -31st January 2021	PAC
9	Circulation of the draft to Expert Groups for comments	1st - 7th February 2021	PAC Chair
10	Circulation of the revised RPF to NRs and to WG for drafting of the MTS for comments	16th February 2021	PAC chair
11	Submission of the revised RPF for the approval of the 43rd NRM	26th March 2021 (one month prior to the NRM –GOR Part 2, Section 2.1)	PAC Chair

*WG for drafting the MTS for 2024-29 was invited to participate

Annex 2

A Summary Report on the Survey on Priorities of RCA GPs

This is a summarized version of the report on the survey conducted by RCA Programme Advisory Committee to identify the priorities of the RCA GPs.

The detailed report can be found at http://rcaro.org/rpf/view/id/22712

1. Introduction

Based on a proposal made by the RCA Programme Advisory Committee (PAC) to the RCA General Conference Meeting held on the 18th of September 2020, the RCA GPs requested the PAC to develop a Regional Programme Framework (RPF) for 2024-29, in consultation with the Working Group on RCA Medium Term Strategy. The purpose of the RPF is to assist the RCA GPs to identify priority areas for the RCA Programme for the period 2024 to 2029.

The methodology adopted by PAC in developing the RPF was to conduct a survey among RCA Government Parties (GPs) to identify their priorities and needs, and to form expert groups in each Thematic Sector to review the outcomes of the survey and details of past RCA projects to identify strategic priorities for the future. A similar exercise was carried out to develop the RCA Strategic Priorities for 2012-2017 and for 2018-2023.

The purpose of this report is to provide a summary of the outcomes of the survey to the expert groups to assist them in identifying future priorities. A separate report containing the achievements and other details of the RCA Projects implemented since 2007 will also be provided to the expert groups.

2. Methodology

An online survey was conducted between 14th October to 4th December to identify the needs and priorities of the RCA GPs. 20 RCA GPs out of 22 (91%) responded. The survey was conducted on Google Forms which facilitated the compilation and processing of the responses.

The GPs were requested to prioritize project areas according to five categories with corresponding marks for each (very high priority – 5 marks;, high priority – 4 marks; medium priority – 3 marks; low priority – 2 marks; and very low priority – 1 mark). See page xx for the definitions of the levels of priority. The project areas were based on past RCA activities.

3. Results of the Survey - Overall prioritization

The table below gives the prioritization order of the project areas in all Thematic Sectors, obtained from the weighted averages calculated by assigning numerical values to the priority levels assigned by the GPs. (From 5 for very high priority to 1 for very low priority) The definitions of the levels of priority are given in Annex 1. The prioritizations by Thematic Sector are given in Section 4.

Priority	Project Area	Thematic Sector	Weighted Average
1	Radiation Oncology	Human Health	4.85
2	Medical Physics	Human Health	4.80
3	Nuclear Medicine	Human Health	4.75
4	Water Resources Management	Environment	4.40
5	Radiation Protection	Other areas	4.30
6	Food Safety	Agriculture	4.20

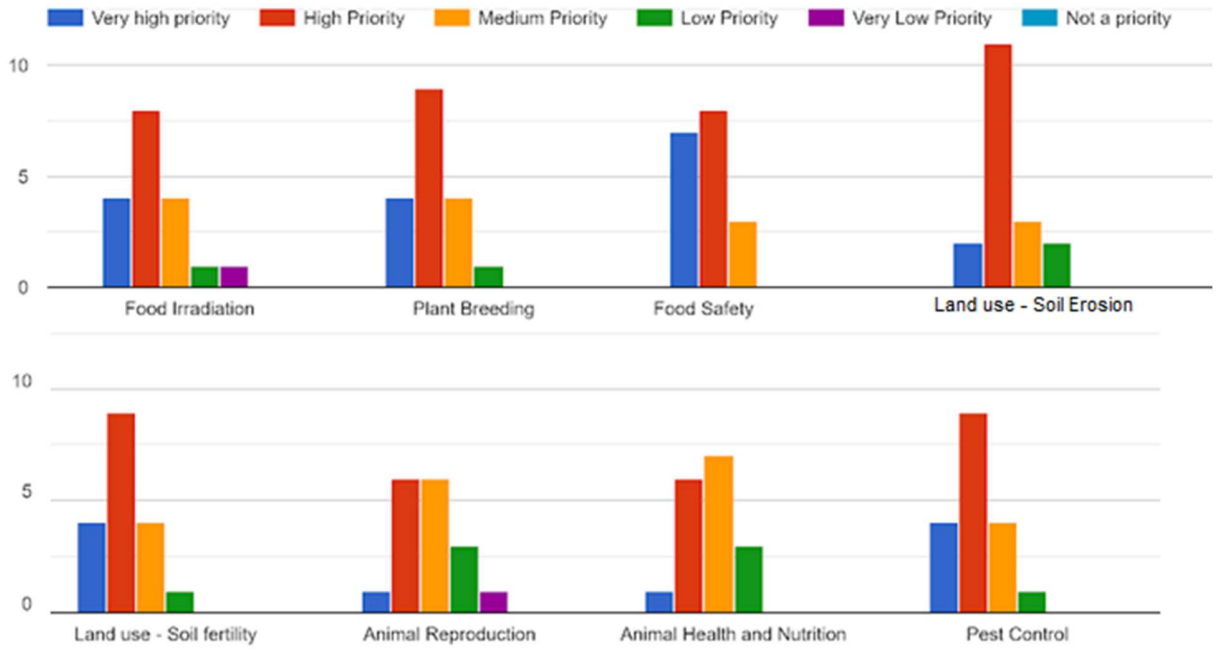
Priority	Project Area	Thematic Sector	Weighted Average
6	Non-destructive Testing	Industry	4.20
8	Air Pollution Monitoring	Environment	4.15
9	Plant Breeding	Agriculture	4.00
10	Pest Control	Agriculture	3.80
10	Marine and Coastal Environment	Environment	3.80
12	Food Irradiation	Agriculture	3.75
12	Land use - Soil fertility	Agriculture	3.75
12	Energy Planning	Other areas	3.75
15	Land Use - Soil Erosion and Contamination	Agriculture	3.65
16	Radiation Processing	Industry	3.60
17	Research Reactor Utilization	Other areas	3.55
18	Radioimmunoassay (RIA)	Human Health	3.45
19	Nuclear tracers and sealed sources	Industry	3.25
20	Nutrition	Human Health	3.15
20	Nuclear Instrumentation	Other areas	3.15
22	Animal Health and Nutrition	Agriculture	3.10
23	Nuclear Gauges and NCS	Industry	3.05
24	Animal Reproduction	Agriculture	3.00
24	Dam Safety	Environment	2.85
26	Tissue grafting	Human Health	2.45

4. Results of the Survey - Priorities by Thematic Sectors

4.1 Thematic Sector – Agriculture

Eight project areas based on the previously implemented RCA projects were considered for the Survey. The following table summarizes the overall prioritization, based on the weighted averages calculated from the levels of priorities assigned by the GPs.

Priority	Project Area	Weighted Average
1	Food Safety	4.20
2	Plant Breeding	4.00
3	Pest Control	3.80
4	Land use - Soil fertility	3.75
4	Food Irradiation	3.75
6	Land Use - Soil Erosion and Contamination	3.65
7	Animal Health and Nutrition	3.10
8	Animal Reproduction	3.00



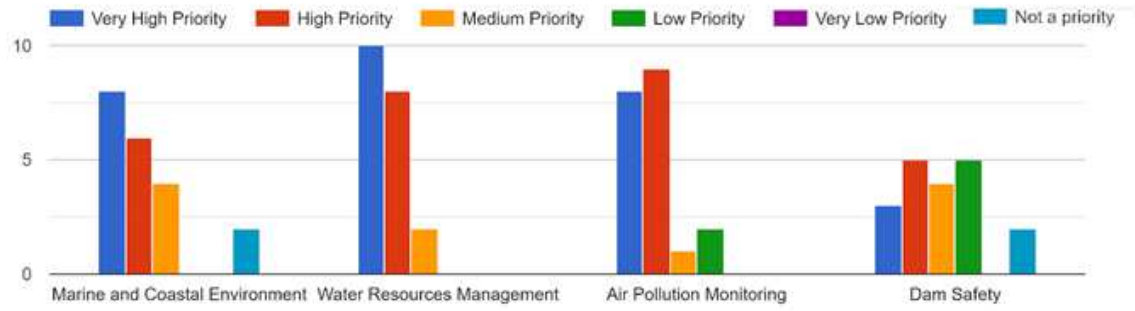
Additional project areas suggested by GPs

- Smart Agriculture & Green House Gas (GHG) Emissions Reductions
- Fishery resources management
- Holistic cyclo - farming system in which agriculture and livestock become a closed system in utilizing natural resources in a sustainable manner
- Developing Modern, Digital Soil Information System (DSIS) and Remote Sensing Harmonization through Nuclear Techniques

4.2 Thematic Sector – Environment

Four project areas based on the previously implemented RCA projects were considered for the Survey. The following table summarizes the overall prioritization, based on the weighted averages calculated from the levels of priorities assigned by the GPs.

Priority	Project Area	Weighted Average
1	Water Resources Management	4.40
2	Air Pollution Monitoring	4.15
3	Marine and Coastal Environment	3.80
4	Dam Safety	2.85



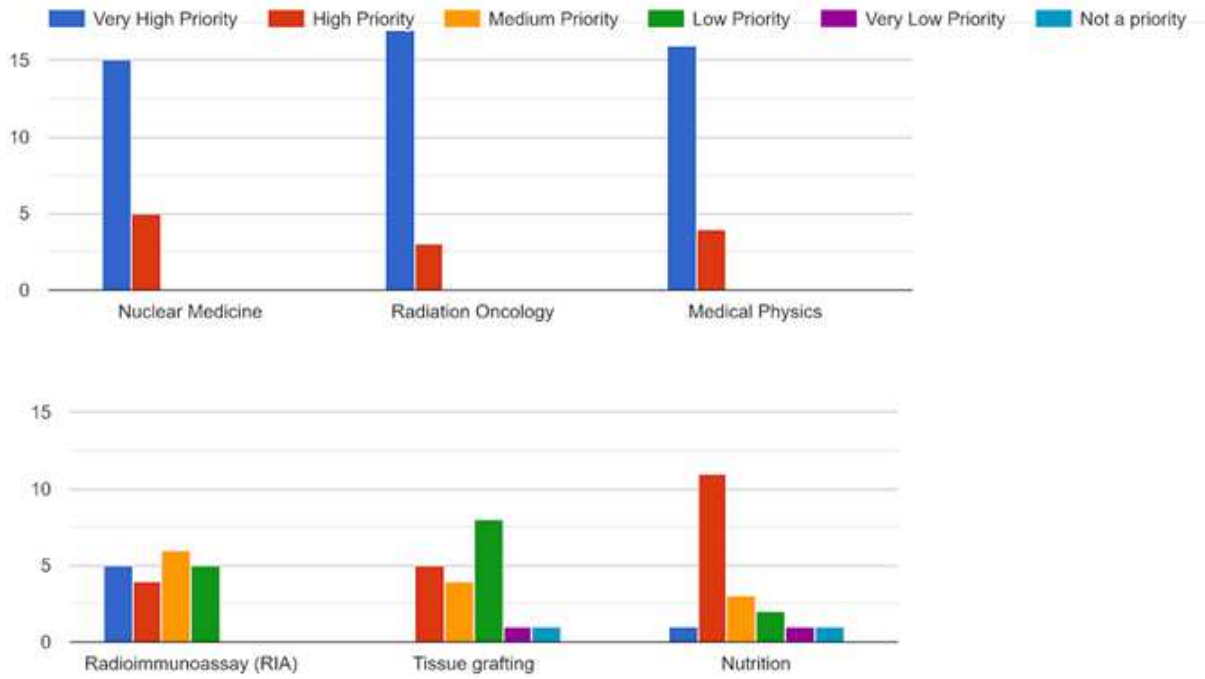
Additional project areas suggested by GPs

- Water resources management: integrated water governance
- Conserving and preserving cultural heritage
- Climate change
- Environmental forensics using nuclear techniques
- Inland ecosystem management – lakes and rivers
- Geothermal energy
- Radioactive contamination of ground water (due to mining operations and nuclear waste disposal)

4.3 Thematic Sector – Human Health

Six project areas based on the previously implemented RCA projects were considered for the Survey. The following table summarizes the overall prioritization, based on the weighted averages calculated from the levels of priorities assigned by the GPs.

Priority	Project Area	Weighted Average
1	Radiation Oncology	4.85
2	Medical Physics	4.80
3	Nuclear Medicine	4.75
4	Radioimmunoassay (RIA)	3.45
5	Nutrition	3.15
6	Tissue grafting	2.45



Additional project areas suggested by GPs

- Radioisotopes production for nuclear medicine examination – Adolescent/ maternal (pregnancy/lactation)
- Nutrient requirement based on early life nutrition; impact evaluation of the first 1,000 days policy and program implementation
- Verification of Dietary Reference Intake (DRI) as a basis for food-based dietary guidelines; appraisal of nutrient quality and safety within the context of healthy and sustainable diet
- Accelerator development and utilization – Proton and Carbon Ion therapy technology including human resource preparation.
- Development of brachytherapy sources for cancer treatment
- Diagnostic radiology
- Myocardial perfusion imaging and dynamic PET/CT.

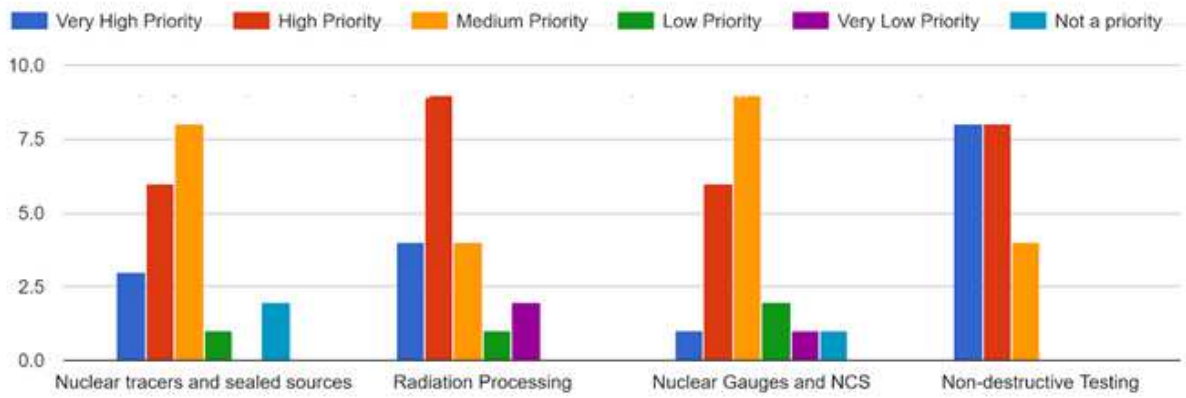
Other suggestions

- Establishment of a network of supply chain for medical radionuclides that can provide timely, reliable and affordable delivery in the region
- Establishment of QC training programmes for radiotherapy equipment and carrying out quality audits for linac machines

4.4 Thematic Sector – Industry

Four project areas based on the previously implemented RCA projects were considered for the Survey. The following table summarizes the overall prioritization, based on the weighted averages calculated from the levels of priorities assigned by the GPs.

Priority	Project Area	Weighted Average
1	Non-destructive Testing	4.20
2	Radiation Processing	3.60
3	Nuclear tracers and sealed sources	3.25
4	Nuclear Gauges and NCS	3.05



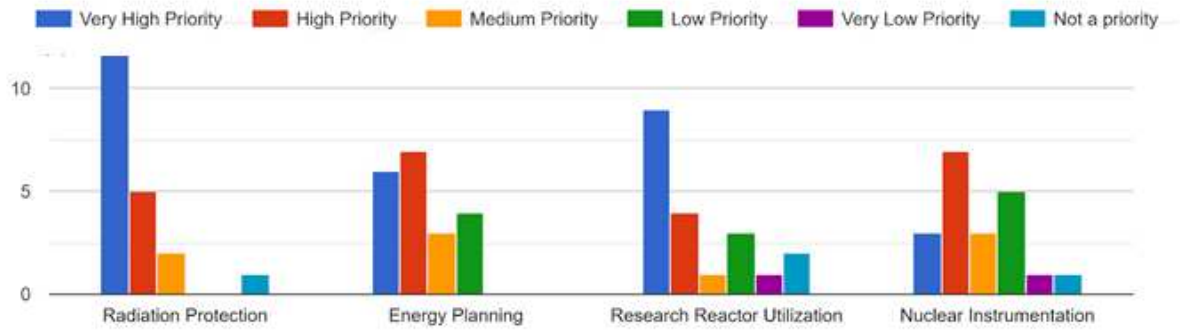
Additional project areas suggested by GPs

- Use of nuclear technology for reduction of plastic waste and increase of utilization of plastic waste
- Non-Destructive Testing: Introduction of new NDT Technology such as Digital Radiographic Testing.

4.5 Other areas

Four project areas based on the previously implemented RCA projects were considered for the Survey. The following table summarizes the overall prioritization, based on the weighted averages calculated from the levels of priorities assigned by the GPs.

Priority	Project Area	Weighted Average
1	Radiation Protection	4.30
2	Energy Planning	3.75
3	Research Reactor Utilization	3.55
4	Nuclear Instrumentation	3.15



Additional project areas suggested by GPs

- Nuclear Power : SMR technology, public awareness and outreach
- Education and training in nuclear science
- Radiation protection, safety culture and waste management
- Research reactors and simulator training

5. Priorities of new RCA GPs

The priorities of the GPs that joined the RCA recently were identified separately since they could be different from that of GPs who had benefitted from the RCA over a longer period of time. Four out of the five new GPs responded to the survey. The first 10 priority areas identified by the new GPs are given below.

Priority	Project Area	Thematic Sector	Weighted Average
1	Radiation Protection	General	5.00
2	Medical Physics	Human Health	4.75
3	Nuclear Medicine	Human Health	4.5
4	Radiation Oncology	Human Health	4.5
5	Air Pollution Monitoring	Environment	4.25
6	Nutrition	Human Health	4.25
7	Animal Reproduction	Agriculture	4.00
8	Animal Health and Nutrition	Agriculture	4.00
9	Water Resources Management	Environment	4.00
10	Dam Safety	Environment	4.00

The first five priorities indicated by the new GPs, match well with overall priorities of all GPs to a large extent. However, the specific needs within these priority areas could be different from those of the other GPs. The first ten overall priorities of all GPs are given below for comparison.

Priority	Project Area	Thematic Sector	Weighted Average
1	Radiation Oncology	Human Health	4.85
2	Medical Physics	Human Health	4.80
3	Nuclear Medicine	Human Health	4.75
4	Water Resources Management	Environment	4.40
5	Radiation Protection	General	4.30
6	Food Safety	Agriculture	4.20
6	Non-destructive Testing	Industry	4.20
8	Air Pollution Monitoring	Environment	4.15
9	Plant Breeding	Agriculture	4.00
10	Pest Control	Agriculture	3.80

Definitions of Priority Levels

Very High Priority:

- Relevant organizations in the country are willing to invest in developing human and/or capital resources related to the project area.
- The project area is linked to ongoing development programmes in the country.
- The potential for socio-economic benefits is very high

High Priority:

- Relevant organizations in the country, especially stakeholders or beneficiaries, are willing to collaborate in the project area.
- The project area is included or mentioned in the long-term development plan document of the country.
- The project area addresses a major issues, problems, or concern in the country.
- There is a good potential to achieve socio-economic benefits

Medium Priority:

- The need for such a project exists. There are problems in that project area that could be solved using nuclear technology
- Some capabilities and resources already available in the country and the project would further boost these capabilities and resources to take it to field implementation.
- The project could provide socio-economic benefits

Low Priority:

- The project area is of scientific interest only. It might contribute to future national development programmes.

Very Low Priority:

- The project area is of scientific interest only. Its contribution even to future national development programmes is very unlikely

Not a Priority:

- The project area is of no relevance to the country. Example: Projects on Research Reactor Utilization for Countries without research reactors.

Annex 3

Summary Details of RCA Projects Implemented since 2007

This contains summary details of the RCA Projects implemented since 2007. The detailed report can be found at http://rcaro.org/projectsummary/view/id/22682

List of RCA Projects Implemented since 2007

Thematic Sector: Agriculture

No	Project Area	Project Number	Title	Implem. Period	Lead Country
1	Plant Breeding	RAS5045	Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA)	2007-2010	China
2		RAS5056	Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change (RCA)	2012-2015	China
3		RAS5070	Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)	2015-2018	Indonesia
4		RAS5077	Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA)	2017-2020	China
5		RAS5088	Enhancing Crop Productivity and Quality through Mutation by Speed Breeding (RCA)	2021-2024	China
6	Food Irradiation	RAS5046	Novel Applications of Food Irradiation Technology for Improving Socioeconomic Development (RCA)	2007-2010	China
7		RAS5050	Enhancing Sanitary and Phytosanitary Treatment of Regional Products for Export by Irradiation (RCA)	2009-2011	Australia
8		RAS5057	Implementing Best Practices of Food Irradiation for Sanitary and Phytosanitary Purposes (RCA)	2012-2014	China
9		RAS5071	Strengthening Adaptive Climate Change Strategies for Food Security through the use of Food Irradiation (RCA)	2014-2016	Philippines
10		RAS5087	Promoting Food Irradiation by Electron Beam and X Ray Technology to Enhance Food Safety, Security and Trade (RCA)	2020-2023	New Zealand
11	Soil Fertility	RAS5055	Improving Soil Fertility, Land Productivity and Land Degradation Mitigation (RCA)	2012-2015	Australia
12		RAS5084	Assessing and Improving Soil and Water Quality to Minimize Land Degradation and Enhance Crop Productivity Using Nuclear Techniques (RCA)	2018-2021	Australia
13	Food Safety	RAS5081	Enhancing Food Safety and Supporting Regional Authentication of Foodstuffs through Implementation of Nuclear Techniques (RCA)	2018-2021	New Zealand

Thematic Sector: Environment

No	Project Area	Project Number	Title	Implem. Period	Lead Country
1	Marine and coastal environment	RAS7016	Establishing a Benchmark for Assessing the Radiological Impact of Nuclear Power Activities on the Marine Environment in the Asia-Pacific region (RCA)	2007-2010	Australia
2		RAS7019	Harmonizing Nuclear and Isotopic Techniques for Marine Pollution Management at the Regional Level (RCA)	2009-2011	The Philippines
3		RAS7021	Marine benchmark study on the possible impact of the Fukushima radioactive releases in the Asia-Pacific Region (RCA)	2011-2014	Australia
4		RAS7024	Supporting Nuclear and Isotopic Techniques to Assess Climate Change for Sustainable Marine Ecosystem Management (RCA)	2012-2014	The Philippines
5		RAS7028	Enhancing Regional Capabilities for Marine Radioactivity Monitoring and Assessment of the Potential Impact of Radioactive Releases from Nuclear Facilities in Asia-Pacific Marine Ecosystems (RCA)	2016-2019	Indonesia
6		RAS7031	Assessing the Vulnerability of Coastal Landscapes and Ecosystems to Sea-Level Rise and Climate Change (RCA)	2018-2021	Australia
7	Water Resources	RAS8104	Assessment of Trends in Freshwater Quality Using Environmental Isotopes and Chemical Techniques for Improved Resource Management (RCA)	2007-2008	Pakistan
8		RAS8108	Assessing Trends in Freshwater Quality Using Environmental Isotopes and Chemical Techniques for Improved Resource Management (RCA)	2009-2011	Pakistan
9		RAS7022	Applying Isotope Techniques to Investigate Groundwater Dynamics and Recharge Rate for Sustainable Groundwater Resource Management (RCA)	2012-2015	Pakistan
10		RAS7030	Assessing Deep Groundwater Resources for Sustainable Management Through the Utilization of Isotopic Techniques (RCA)	2016-2019	Pakistan
11		RAS7035	Enhancing Regional Capability for the Effective Management of Ground Water Resources Using Isotopic Techniques (RCA)	2020-2023	Pakistan

No	Project Area	Project Number	Title	Implem. Period	Lead Country
12	Air Pollution Monitoring	RAS7015	Characterization and Source Identification of Particulate Air Pollution in the Asian Region (RCA)	2007-2010	New Zealand
13		RAS7023	Supporting Sustainable Air Pollution Monitoring Using Nuclear Analytical Technology (RCA)	2012-2015	New Zealand
14		RAS7029	Assessing the Impact of Urban Air Particulate Matter on Air Quality (RCA)	2016-2018	New Zealand
15	Wetland Management	RAS7037	Enhancing Wetland Management and Sustainable Conservation Planning (RCA)	2020-2023	Australia

Thematic Sector: Human Health

No	Project Area	Project Number	Title	Implem. Period	Lead Country
1	Nuclear Medicine	RAS6049	Strengthening Clinical Applications of PET in RCA Member States (RCA)	2007-2008	India
2		RAS6061	Improving Cancer Management with Hybrid Nuclear Medicine Imaging (RCA)	2012-2014	India
3		RAS6063	Strengthening the Application of Nuclear Medicine in the Management of Cardiovascular Diseases (RCA)	2012-2014	Philippines
4		RAS6064	Building Capacity with Distance Assisted Training for Nuclear Medicine Professionals	2012-2013	Australia
5		RAS6076	Improving Cancer Management Through Strengthening the Computed Tomography Cancer Staging Process (RCA)	2014-2016	Republic of Korea
6		RAS6083	Improving Patient Care and Enhancing Government Parties Capacity in Nuclear Medicine programmes in RCA Region (RCA)	2016-2018	Republic of Korea
7		RAS6093	Strengthening Capacity to Manage Non-Communicable Diseases Using Imaging Modalities in Radiology and Nuclear Medicine (RCA)	2018-2021	Republic of Korea
8	Radiation Oncology	RAS6048	Application of High-Precision 3D Radiotherapy for Predominant Cancers in the RCA region (RCA)	2007-2008	Japan
9		RAS6053	Improving Image Based Radiation Therapy for Common Cancers in the RCA Region (RCA)	2009-2013	Japan
10		RAS6062	Supporting 3D Image-Guided Brachytherapy Services	2012-2015	Japan

No	Project Area	Project Number	Title	Implem. Period	Lead Country
11	Radiation Oncology	RAS6065	Strengthening the Application of Stereotactic Body Radiation Therapy to Improve Cancer Treatment (RCA)	2012-2015	Republic of Korea
12		RAS6066	Reducing the Shortage of Oncology Professionals through an Applied Sciences of Oncology Course (ASOC)	2012	Australia
13		RAS6071	Strengthening Radionuclide Therapy for High Impact Cancer Treatment Strategy in Member States of the Regional Cooperative Agreement (RCA)	2014-2016	India
14		RAS6072	Strengthening Intensity Modulated Radiation Therapy Capability in the Region (RCA)	2014-2016	Japan
15		RAS6085	Enhancing Stereotactic Body Radiation Therapy for Frequent Cancers in the RCA Region (RCA)	2016-2019	Republic of Korea
16		RAS6086	Strengthening Cancer Management Programmes in RCA States Parties through Collaboration with National and Regional Radiation Oncology Societies (RCA)	2018-2021	Japan
17		RAS6096	Empowering Regional Collaboration among Radiotherapy Professionals through Online Clinical Networks (RCA)	2020-2023	
18	Medical Physics	RAS6038	Strengthening Medical Physics through Education and Training (RCA)	2003-2012	Australia
19		RAS6077	Strengthening the Effectiveness and Extent of Medical Physics Education and Training (RCA)	2014-2017	Australia
20		RAS6087	Enhancing Medical Physics Services in Developing Standards, Education and Training through Regional Cooperation (RCA)	2018-2021	Australia
21	Radiopharmaceuticals	RAS6097	Enhancing Capacity and Capability for the Production of Cyclotron-Based Radiopharmaceuticals (RCA)	2020-2023	Republic of Korea

Thematic Sector: Industry

No	Project Area	Project Number	Title	Implem. Period	Lead Country
1	Applications of nuclear tracers and sealed sources	RAS8107	Raising Productivity in the Coal, Minerals and Petrochemical Industries by using Nucleonic Analysis Systems and Radiotracers (RCA)	2007-2008	Australia
2		RAS8111	Diagnosing Industrial Multiphase Systems by Process Visualization using Radiotracers and Sealed Sources (RCA)	2009-2011	China
3		RAS1012	Characterizing and Optimizing Process Dynamics in Complex Industrial Systems Using Radiotracer and Sealed Source Techniques	2012-2016	Pakistan
4	Radiation Processing	RAS8106	Radiation Processing Applications for Health and the Environment (RCA)	2007-2008	Philippines
5		RAS8109	Supporting Radiation Processing of Polymeric Materials for Agricultural Applications and Environmental Remediation (RCA)	2009-2012	Malaysia
6		RAS1014	Supporting Radiation Processing for the Development of Advanced Grafted Materials for Industrial Applications and Environmental Preservation	2012-2014	Malaysia
7	Nondestructive Testing	RAS8105	Development and Application of Advanced Industrial Radiography and Tomography Techniques (RCA)	2007-2008	India
8		RAS8110	Applying Advanced Digital Industrial Radiology and Computed Tomography in Industry and Civil Engineering (RCA)	2009-2011	India
9		RAS1013	Supporting Advanced Non-Destructive Examination for Enhanced Industrial Safety, Product Quality and Productivity	2012-2014	India
10		RAS1020	Building Capacity for Applications of Advanced Non-Destructive Evaluation Technologies for Enhancing Industrial Productivity (RCA)	2014-2016	India
11		RAS1022	Strengthening Regional Capacity in Non-Destructive Testing and Examination Using Nuclear and Related Techniques for Safer, Reliable, More Efficient and Sustainable Industries Including Civil Engineering (RCA)	2018-2021	Malaysia

Thematic Sector: Radiation Safety

No	Project Area	Project Number	Title	Implem. Period	Lead Country
1	Radiation Protection Infrastructure	RAS9042	Sustainability of Regional Radiation Protection Infrastructure (RCA)	2007-2010	Australia / Japan
2	Emergency Response	RAS9092	Strengthening the Capacity to Respond to Radiological Emergencies of Category II and III Facilities (RCA)	2020-2023	Republic of Korea

No	Project Area	Project Number	Title	Implem. Period	Lead Country
1	Research Reactor Utilization	RAS4026	Adding Value to Materials through Irradiation with Neutrons (RCA)	2007-2008	Republic of Korea
2	Energy Planning	RAS0045	Formulation of Sustainable Energy Development Strategies in the Context of Climate Change (RCA)	2007-2008	Republic of Korea

Projects by Sector and Year

Thematic Sector : Agriculture

Project Area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Mutation Plan Breeding	RAS5045					RAS5056				RAS5077							
								RAS5070						RAS5088			
Food Irradiation	RAS5046					RAS5057								RAS5087			
			RAS5050					RAS5071									
Land use – Soil Erosion						RAS5055						RAS5084					
Food Safety												RAS5081					
Water and soil quality																NEW	
Water use																NEW	
Land use – Fertilizer uptake																	
Animal Health and Nutrition																	
Animal Reproduction																	

Thematic Sector : Environment

Project Area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Marine and coastal environment	RAS7016					RAS7024				RAS7028							
			RAS7019									RAS7031					
					RAS7021												
Development of water resources	RAS8104		RAS8108			RAS7022				RAS7030				RAS7035			
																NEW	
Air-Pollution	RAS7015					RAS7023				RAS7029							

Wetland Management														RAS7037

Thematic Sector : Human Health

Project Area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Nuclear Medicine	RAS6049					RAS6063				RAS6083							
						RAS6064						RAS6093					
						RAS6061											
						RAS6076											
Radiation Oncology	RAS6048		RAS6053							RAS6085							
						RAS6062						RAS6086					
						RAS6065								RAS6096			
						RAS6066		RAS6071								NEW	
								RAS6072								NEW	
																NEW	
Medical Physics	RAS6038																
								RAS6077				RAS6087					
Radiopharmaceuticals														RAS6097			

Thematic Sector : Industry

Project Area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Tracer Technology	RAS8107		RAS8111			RAS1012											
Radiation Processing	RAS8106		RAS8109													NEW	
						RAS1014											
Nuclear Gauges and Nucleonic Control Systems																	
Non-destructive Testing	RAS8105		RAS8110			RAS1013			RAS1020			RAS1022				NEW	

Thematic Sector : Radiation Safety

Project Area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Radiation Safety	RAS9042													RAS9092			

Thematic Sector: Other areas

Project Area	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Energy Planning	RAS0045																
Research Reactor Utilization	RAS4026																

Project Distribution