Report on

IAEA/RCA Executive Meeting on Application of Isotope Techniques to Solve Hydrological Problems (RAS/8/108)

Kuala Lumpur, Malaysia 20-24 April 2009

IAEA Officer

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1. Introduction

1.1 Background and Scope

Water is one of the core elements of human existence. Over the last several decades, surface and groundwater resources are increasingly under pressure for a number of reasons such as increasing demand for food, increasing urbanization and industrialization. Only a very small fraction of the global water is of suitable quality for use, and only a small fraction of that is divertible. Groundwater resources are often the only source of reliable, clean water in many parts of the world. Even in areas where the annual rainfall is high, access to stored water is still required to maintain the water demand as the rainfall remains for only a short period of time.

Very often, the sustainable use of groundwater is limited by both water quality and potential recharge area. The quality is mainly affected by ingression of contaminants from adjacent water bodies, which might be resulting from over exploitation of groundwater sources or as a consequence of previous years of indiscriminant untreated waste disposal. Finally, an important aspect that has not been traditionally considered is the contamination by natural sources of otherwise fresh waters. The classic case example is the arsenic laden waters in many countries of the region.

If groundwater contamination is to be addressed effectively, one needs tools to be able to trace the movement, sources and fate of contaminants. Environmental isotope tracers have the ability to do that because of their unique ‘fingerprinting’ of sources that are often preserved within the subsurface, and the radioactive natural isotopes that provide a time scale of subsurface flow. The application of environmental isotope technologies is well developed for understanding processes and tracing the sources, movement and fate of groundwater contaminants. Adoption of the technology to the water agency managers and policy makers has been less successful. There are many reasons for this, such as lack of knowledge regarding the unique information afforded by isotope techniques, poor access to isotopic analyses, lack of effort to make the isotopic applications relevant etc. However, the techniques very often are extremely powerful and definitive in evaluating groundwater movement, and sources and fate of contaminants. Therefore their use should be encouraged and adopted as much as possible by water resource managers.

1.2 Participation

Eighteen participants from 12 countries: Bangladesh (2), China (1), India (2), Indonesia (1), Korea (1), Malaysia (3), Myanmar (1), Pakistan (1), Philippines (1), Sri Lanka (2), Thailand (2) and Vietnam (1) attended the meeting. The agency was represented by Mr. P.K.

Aggarwal, Head Isotope Hydrology Section (Technical Officer). Mr. Manzoor Ahmad Choudhry (Pakistan) participated as IAEA Expert. List of the participants and the Meeting Program are given in Annexes 1 and 2 respectively.

1.3 Opening

The opening ceremonies commenced with welcome and opening addresses from Mr. Mohd Noor Bin Mohd Younus, Deputy Director General on behalf of the Malaysian Nuclear Agency. Mr. Manzoor Choudhry, Project Lead Country Coordinator spoke on behalf of the IAEA.

Mr. Mohd Tadza Abdul Rahman, Malaysian Nuclear Agency was elected as Chairperson of the meeting and Mr. Mizanur Rahman and Mr. Tirumalesh Keesari were assigned as rapporteurs.

1.4 What did this meeting seek to achieve?

The purpose of the meeting was to discuss with the senior executives/professionals of participating RCA Member States on the emerging issues/needs in water resources development and management and provide them knowledge of advantages and utility of isotope techniques in understanding of surface water-groundwater and inter-aquifers hydraulic interactions, and the delineation of pathways of recharge flow and contaminant migration in groundwater. The people involved were not necessarily familiar with application of isotopic methodologies, but have the responsibility to manage groundwater resources. The aim was to better understand their needs, and for them to provide feedback as to what sort of isotope and geochemical information is most useful in developing appropriate monitoring and amelioration strategies.

The meeting adopted the following aspects to achieve the above overall objective:

1. Identify the salient surface water/groundwater issues for each of the representative countries in the RCA region.
2. Synthesize these issues into common themes
3. Prioritize the issues in importance within each member country
4. Evaluate the information needs for each theme
5. Identify where isotopes add value to existing knowledge
6. Determine what actions need to be initiated
7. Inputs required from The Agency

The following sections outline the titles of country presentations, main issues identified on basis of these presentations and items for action deriving from group discussions.

2. Presentations: Country Reports/Lectures

Brief summaries of the country reports are given in Annex 3. Titles of the presentations are the following.

Overview of the Project – Mr. M.A. Choudhry, Project Lead Country Coordinator (PLCC)

Bangladesh: Mr. Mizanur Rahman,
Application of Isotope Technique to Solve Hydrological Problems in Bangladesh

Mr. Nasir Ahmed
Use of Environmental Isotopes to Study Deep Groundwater Resources in Alluvial Deposits of Singair Upazil and Manikganj Districts

China: Mr. Zhiming Wang
Isotopes and Geochemical studies on Surface water and groundwater quality in Huaihe River Area

India: Mr. Kavallappa Shivanna,

Isotope and Geochemical Approach for the Rejuvenation of Drying Springs in Himalayan Region of Gaucher Area, Uttarakhand, India

Mr. K.Tirumalesh

Impact Assessment of Sewerage Network on the Groundwater System of Arkavathi and Vrishbhavati Basins of Bangalore, Karnataka using Hydrochemistry and Environmental Isotope Techniques

Indonesia: Mr. Syamsu Daliend

Environmental Isotopes and Chemical Techniques for Improved Groundwater Resources Management at East Kalimantan

Korea: Mr. Geon Young Kim

Application of isotope techniques and hydrological and hydrochemical investigation techniques to solve the geogenic contamination, especially about high uranium contents of groundwater

Malaysia: Mr. Mohd Tadza Abd. Rahman

To assess the trend of freshwater quality in Langkawi Island

Mr. Mohammad Hatta Husin and Mr. Amran Kamaruddin

Application of isotope techniques to solve hydrological problems due to sewage seepage into groundwater in Kelantan State, Malaysia

Myanmar: Ms. Thu Zar Lwin Oo

Overview of water problems in the country

Pakistan: Mr. Allah Bakhsh Sufi

Water resources of Pakistan – current Issues and way forward

Philippines: Mr. Francisco Arellano and Mr. Ferdie Billones

Philippines Country Report

Sri Lanka: Mr. Galapitagedara R.R. Kuranaratne, Mr. S.K.S.K. Harsha Suriyaarachchi

Investigation of the Trends in Water Quality Deterioration of Northwestern Limestone Aquifer System of the Puttalam District

Thailand: Mr. Adisai Charuratna
Application of Isotope Hydrology for Solving Nitrate Genesis in Groundwater Northeastern Part of Thailand

Mr. Kriengsak Srisuk

Use of Isotope Hydrology for Groundwater Resources Study in the Upper Chi River Basin, Chaiyaphum, NE-Thailand

Vietnam: Mr. Nguyen Kien Chinh
To define the source of nitrate in groundwater of Hochiminh City using isotope techniques

Lecture: IAEA's Water Resources Programme and Case Studies - Isotope Applications for Water Resource Management - Mr. P.K. Aggarwal

Lecture: Basic Principles of Isotope Techniques and Case Studies - Mr. M.A. Choudhry

Lecture: Tritium-Helium Dating for Groundwater-Surface Water Assessment - Mr. P.K. Aggarwal

Overview of country reports and discussions of local and regional issues – Mr. Choudhry and Mr. Aggarwal

Presentations and discussions on the output of the Groups - Mr. Choudhry and Mr. Aggarwal

3. Water-related issues identified by representatives from Member States

Country	Problem	Information required
Bangladesh	Arsenic contamination of shallow groundwater in Singair area	-Better understanding of As source and release mechanism -Interconnection between shallow and deep layers -Groundwater dynamics
	Point source contamination of	-Contaminated river water inflow

	groundwater (industrial /landfill)	to aquifer
	Sustainability of Dhaka aquifer	-Recharge area and potentiality of aquifer corridor
China	Contamination of surface water and groundwater in Huaihe River Basin by agrochemicals and industrial/urban waste	-Interconnection between surface water and groundwater -Sources and transport of contaminants
India	Contamination of groundwater by industrial and urban waste in Bangalore area, Karnataka	-Quality of groundwater -Understanding of recharge and discharge processes -Impact of sewerage drains on groundwater
	Radon pollution in the groundwater	-Radon and uranium levels
Indonesia	Declining piezometric levels & sustainability concerns	-Identification of recharge zones -SW-GW interaction -Groundwater potential
	Contamination of river water and groundwater by industrial and urban wastes	-Water quality and source of pollutants -Surface water inflow to main aquifer
Korea	Groundwater contamination from anthropogenic activities (mine drainage, agricultural and industrial activities)	-Groundwater quality -Interconnection between surface water and groundwater -Source & transport of contaminants
	Geogenic contamination of groundwater by uranium	-Identification of U bearing minerals and release mechanism Groundwater flow paths
Malaysia	Groundwater quality under contamination threat from both point and non point sources in Langkawi Island and Kelantan State	- Surface water – groundwater interaction - Contaminant source and migration
Myanmar	Surface water and groundwater contamination	- Quality of surface water and groundwater - Identification of contaminant sources (urban, industrial and agrochemical)
Pakistan	Impact of constructed reservoirs/canals on local groundwater system	-Lateral and vertical contribution of surface water in groundwater
	Water logging and increase of soil salinity	- Recharge sources - Salinization processes
	Contamination of groundwater	- Quality of SW & GW

	from urban industrial and agrochemical waste	- Identification of contaminant sources (urban, industrial and)
	Groundwater sustainability	- Identification of recharge zones -SW-GW interaction -Groundwater potential
Philippines	Surface water and groundwater pollution by agricultural activities and urban waste	- Quality of surface water and groundwater - Identification of contaminant sources (urban and agrochemical)
	Seawater intrusion in coastal areas	- Delineating fresh water/seawater interface
	Sustainability of water resources (deficit)	- Identification of recharge zones - SW-GW interaction - Groundwater potential
Sri Lanka	Groundwater quality deterioration due to saline water intrusion in Puttalam and Anuradhapura	- Groundwater quality - Source of salinity
	Groundwater sustainability in Sudugala	- Identification of recharge zones -SW-GW interaction -Groundwater potential
Thailand	NO_3 pollution in groundwater	- Identification of NO_3 source(s) - Groundwater recharge source and area
	Sustainability of water resources	Northern Part of the Chaopraya Basin, Eastern Sea Board and Hard Rock Terrain in the Kong Chi Mun Basins are facing groundwater scarcity
Vietnam	Groundwater level depletion	- Identification of recharge zone - SW-GW interaction - Groundwater potential
	Groundwater contamination from geogenic and anthropogenic sources	- Quality of surface water and groundwater - Identification of contaminant sources and transport process
	Surface water quality deterioration	-Nature of contaminants and sources

4. Synthesis of presentations

4.1 Issues / Problems

The individual presentations from the countries could be categorized into six common themes as follows: anthropogenic contamination, geogenic contamination, sustainability, surface water – groundwater interaction, groundwater salinization, education & training. These were subsequently consolidated into two general themes:

A. Groundwater Sustainability
B. Water Pollution Investigation

The detailed description of the country-wise issues is given below:

Group – I: Groundwater Sustainability

Country	Problem	Background information
Bangladesh	Sustainability of aquifer yield of Sylhet and Dhaka region	Upper shallow aquifer is under mining situation and the sustainability of the aquifer is under threat, aquifer recharge zone not yet confirmed
India	GW assessment of Arkavathi and Vrishbhavati basins of Bangalore and Karnataka	These aquifers are being exploited indiscriminately, groundwater recharge area and potential is not assessed
Indonesia	Declining piezometric levels & sustainability concerns	Groundwater Resources of Makasar, Lampung and Surabaya are becoming insufficient for water supply
Pakistan	Surface water and groundwater interaction	Kalabagh area, Bhasha Dam, Greater Thal Canal, Rainee Canal, Kachhi Canal and data, water logging problems
Philippines	Sustainability of water resources	Metro Manila Area, scarcity of groundwater resources
Thailand	Sustainability of water resources	Northern Part of the Chaopaya Basin, Eastern Sea Board and Hard Rock Terrain in the Kong Chi Mun Basins are facing groundwater scarcity
Vietnam	Groundwater level depletion	Hochiminh City area is facing groundwater shortage, aquifer resources and recharge area yet to be identified

Environmental isotopes ^{2}H, ^{18}O, ^{3}H (water) ^{13}C & ^{14}C (TDIC), ^{3}H-^{3}He can help investigate various aspects related to sustainability.

Group – II: Water Pollution Investigation

a) Geogenic pollution

Country	Problem	Background information	Isotopes to be used
Bangladesh	Arsenic, Barium Iron, Manganese	Shallow and deep zones, Dhaka city groundwaters.	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, ^{34}S
India	High Radon in groundwater	Arkavathi and Vrishabhavathi basins in Bangalore, Above 1000Bq/m^3, Precambrian formation	^{2}H, ^{18}O, ^{3}H, ^{14}C, ^{222}Rn, ^{226}Ra, ^{238}U
Korea	Uranium in groundwater	Daejeon, About < 1.0 ppm, granitic area, 200-300m deep	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{234}U/^{238}U$, ^{34}S
Myanmar	Arsenic	10-50ppb, Yangon area, Tube wells (~300m)	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, ^{34}S
Pakistan	Arsenic, heavy metal contamination	Indus valley basin, Lahore, Multan, Rainey Canal command area, Muzaffar Ghad, Shallow and deep zones, more than 50ppb.	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, ^{34}S
Sri Lanka	Mn in river water and F in groundwater	Mahaveli river, dry zones of north-central and northwestern area (F: 1-10mg/L),	^{2}H, ^{18}O, ^{3}H, ^{14}C,
Vietnam	Mn in river water	Saigon river, Soil erosion, groundwater discharge into river	^{2}H, ^{18}O, ^{3}H

b) Anthropogenic Pollution

Country	Problem	Background information	Isotopes to be used
China	NO_3, organics	Surface waters Shallow and deep groundwater	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{15}N_{NO3,}$ $^{18}O_{NO3,}$
India	Sewage and industrial contamination	Bangalore city, Akravathi and Vrishabhavathi basins	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{15}N_{NO3,}$ $^{18}O_{NO3,}$ ^{34}S, ^{11}B
Malaysia	Heavy metal pollution	Shallow water of Langkawi, domestic and industrial wastes	^{2}H, ^{18}O, ^{3}H, ^{34}S
Myanmar	Fertilizer and industrial wastes	Shallow zones of Yangon groundwater	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{15}N_{NO3,}$ $^{18}O_{NO3}$
Pakistan	Soan river contaminated by industrial and domestic effluents	Kalabagh area, low DO, BOC, COD	^{2}H, ^{18}O, ^{3}H
Sri Lanka	Cd, As and	Fertilizer, insecticides, landfill	^{2}H, ^{18}O, ^{13}C, ^{3}H,

	agrochemicals in ground and surface waters	sources	^{14}C, ^{34}S, ^{15}N
Thailand	NO_3	Deep groundwater Soil salts	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{15}N_{NO3}$, $^{18}O_{NO3}$,
Vietnam	NO_3 in shallow groundwater	Hochiminh city, Fertilizers, urban wastes, industrial wastes	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{15}N_{NO3}$, $^{18}O_{NO3}$,

c) Salinization

Country	**Problem**	**Background information**	**Isotopes to be used**
Bangladesh	High Cl in shallow and deep aquifers	Seawater intrusion in shallow aquifer and deep seated saline pockets	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{11}B/^{10}B$, ^{37}Cl
Korea	Seawater intrusion	Coastal areas, underground oil storage facilities, 200-400m deep (?)	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{11}B/^{10}B$
Myanmar	Salinity in coastal area	Irrawaddy delta region, tidal influence	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{11}B/^{10}B$
Pakistan	High sodic nature of soils, high EC in water	Kachhi canal command area, water logging, secondary salinization due to evaporative enrichment	^{2}H, ^{18}O and ^{3}H,
Sri Lanka	seawater intrusion in coastal areas, evaporative enrichment	Muthurajavella, Kalpitiya, Puttalam Ambelangoda and Jaffna (coastal area), Northcentral, Northwestern provinces and Hambanthota (dry zones)	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{11}B/^{10}B$
Thailand	Saltwater intrusion in Bangkok	In deep aquifers, May be seawater or vertical leakage	^{2}H, ^{18}O, ^{13}C, ^{3}H, ^{14}C, $^{11}B/^{10}B$

4.2 Information and data needed to address the problem:

The amount and type of information that is needed depends on the respective problem to be addressed. However, nearly every groundwater sustainability and contamination issues require fundamental hydrogeological information as well as information about hydrological fluxes such as recharge, lithological characterization, definition of flow systems, groundwater flow rates and discharge rates. This is, in retrospect, an obvious need given that one seeks to evaluate the movement and fate of contaminants in a worst case (no adsorption/ biodegradation) scenario. The needs identified are:

- basic hydrogeological and hydrological information (rainfall, depth to water, hydraulic conductivity)
- lithological characterisation and aquifer properties
- background hydrochemistry
- defining the groundwater recharge area

- mechanism/rate of recharge
- rate/path of groundwater movement
- inter-aquifer connections
- source of contamination
- affected area to be remediated

5. Summary of Group Discussions on common themes and issues

5.1 Group-I: Groundwater Sustainability

Information needed:

- Definition of the aquifer system including hydrostratigraphic classification
- Understanding of recharge (source, rate, area)
- Groundwater flow dynamics
- Groundwater abstraction for different purposes
- Aquifer interconnection (surface water-groundwater and different aquifers)
- Hydrochemistry of the aquifer system
- Aquifer potential

How isotopes can help:

Environmental isotopes like δ^2H, $\delta^{18}O$ (water, NO_3, SO_4), $\delta^{24}S$, $\delta^{13}C$, $\delta^{15}N$, ^3H, ^3H-^3He and ^{14}C along with hydrochemistry can help investigate:

- Identification of ground water recharge source and area
- Flow rate and dynamics
- Aquifer interconnections
- Understanding hydrochemical evolution
- Validation of mathematical models on groundwater flow

5.2 Group-II: Water Pollution Investigation

Information needed:

- Quality of surface water and groundwater,
- Vertical and horizontal distribution of the contaminants within the aquifer,
- Information on recharge mechanism, groundwater flow paths, dynamics of the aquifer, inter-relation between aquifers, etc.
- Sources of contaminants /salinity (geogenic, urban, industrial, agrochemical, seawater intrusion etc.)
- Identification of geogenic contaminants bearing minerals and mmobilization processes within the aquifer,
- Transport of contaminants, salinization processes and delineating fresh water/ seawater interface

How can Isotopes Help?

Environmental isotopes like δ^2H, $\delta^{18}O$ (water, NO_3, SO_4), $\delta^{24}S$, $\delta^{13}C$, $\delta^{15}N$, ^3H, ^3H-^3He and ^{14}C along with hydrochemistry can help investigate:

- ❖ Origin and source of groundwater recharge
- ❖ Inter connection between different contaminated and non contaminated aquifers
- ❖ Dating of ground water to obtain information on dynamics of the groundwater flow
- ❖ Delineation of the area polluted and sources of contaminants,
- ❖ Rate, direction and distribution of the pollutants
- ❖ To understand the subsurface geochemical environmental conditions for the mobilization of geogenic contaminants
- ❖ To validate the assumptions and concepts made in hydraulic and contaminant transport predictive models

6. Inputs of The Agency

According to the participants, the inputs of IAEA are mainly required to support isotope analysis, some minor equipment/spares/consumables, training and expert services for data interpretation which will be helpful for successful completion of the ongoing RCA Project and sustainable application of isotope techniques in water resources management in future.

In this regard, the PLCC explained that that the Agency had already allocated budget to support the following activities, which would fulfil the requirements of the Member States.

a) Isotope analytical services to the MSs having insufficient facilities

b) Provision of minor equipment, spares, software, scientific supplies etc.

c) Expert Missions

- For field work designing, national training courses and national executive management seminars etc.
- For data interpretation
- For compilation of existing data and data generated through the project for IAEA ISOHIS database
- For preparation of brochure and to draft recommendations and guidelines on the application of isotope techniques

d) Regional events to be implemented

- ➢ Regional Training Course on Advanced Techniques for Isotope and related applications in water resources management. Q/3 2010
- ➢ Project progress review meeting, Q4/2009
- ➢ Final Project evaluation meeting, Q2/2011

7. Conclusions

The meeting has been successful in achieving its objectives.

The meeting helped in identification of the country specific problems and common regional themes. This meeting also assisted in disseminating the information of role of isotope techniques to the participants through lectures and case studies.

This meeting has provided a forum to discuss specific problems of each country in detail and to suggest appropriate isotope methodologies to be adopted in order to solve the hydrological problems. The requirements of the member states were discussed which would help fine-tune the functioning of national and regional activities.

The participants, especially the executives from end-users, viewed this IAEA/RCA Project as being highly worthwhile, and appreciated the support of the Agency.

8. Recommendations to the Participants and NPCs

The recommendations to the Participants of the meeting and the NPCs of the project are:

- To establish strong collaborations between the nuclear institutes and the end-user departments and strengthen the project team for implementation of the project activities and sustainable application of isotope techniques in hydrology and water resources management;

- To raise awareness of isotope methods to end-users through in-house training and national seminars/workshops for end-users on technical and managerial levels, and distributing literature on isotope techniques (books and VCDs);

- To review the national studies under the ongoing RCA project, especially problem definition, planned activities, progress made so far and what to achieve in the remaining period with emphasis on the activities to be completed before the next review meeting in Q4, 2009 and ensure adaption of proper national work plans (In this regard separate correspondence will be made with NPCs by PLCC under the guidelines of Mr. Aggarwal, Head Isotope Hydrology Section/Technical Officer);

- To ensure timely submission of proper progress/final reports to IAEA;

- To disseminate results and guidelines to end-users to make them aware of isotope techniques and formulate policies for sustainable management of water resources.

- To compile isotope and chemical data of previously completed projects and ongoing project, and submit to IAEA.

Annex 2

List of Participants

RAS8108/9001/01
IAEA/RCA Executive Meeting on Application of Isotope Techniques to Solve Hydrological Problems
Malaysia, Kuala Lumpur
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Annex 1

AGENDA

IAEA/RCA Executive Meeting on Application of Isotope Techniques to Solve Hydrological Problems
(RAS/8/108)

Kuala Lumpur, Malaysia
20-24 April 2009

Local organizer:

Mr. Mohd. Tadza Abd. Rahman
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Tentative Agenda

Monday – 20 April 2009

09.00 – 09:30	Registration
09:30 – 10:30	Opening of the meeting
	Welcome Remarks by Dr. Mohd. Tadza Abd. Rahman, Meeting Coordinator, Malaysian Nuclear Agency
	Opening remarks by Mr. M.A. Choudhry, Project Lead Country Coordinator
	Inaugural address by Chief Guest
10.30 – 11:00	*Coffee Break*
11:00 – 11:30	Adoption of Agenda
	Election of the Chairperson and Rapporteurs
	Introduction of Participants
11:30 – 12:30	Overview of the Project – Mr. M.A. Choudhry (Project Lead Country Coordinator)
12:30 – 14:00	*Lunch Break*

Presentations of Country Report

Group 1: Assessment of Groundwater and Surface water Contamination

14:00 – 14:45	Country Report - Bangladesh
14:45 – 15:30	Country Report - Vietnam
15:30 – 16:00	*Coffee Break*
16:00 – 16:45	Country Report – Sri-Lanka
16:45 – 17:30	Country Report - China
17:30 – 18:00	Discussion of the country reports

<u>Tuesday – 21 April 2009</u>

Group 2: Assessment of Surface water-Groundwater interactions

09:00 – 09:45	Country Report - India
09:45 – 10:30	Country Report - Pakistan
10:30 – 11:00	*Coffee Break*
11:00 – 11:45	Country Report - Myanmar
11:45 – 12:30	Country Report - Indonesia
12:30 – 13:00	Discussions of the country reports
13:00 – 14:30	*Lunch Break*

Group 3: Management of Groundwater/Surface water resources

14:30 – 15:15	Country Report - Thailand
15:15 – 16:00	Country Report - Malaysia
16:00 – 16:30	*Coffee Break*
16:30 – 17:15	Country Report - Korea
17:15 – 18:00	Country Report - Philippines
18:00 – 18:30	Discussion of the country reports

<u>Wednesday – 22 April 2009</u>

09:00 – 10:00	IAEA's Water Resources Programme: Case Studies - Mr. P.K. Aggarwal
10:00 – 11:00	Lecture on 'Basic Principles of Isotope Techniques and Applications' - Mr. M.A. Choudhry
11:00 – 11:30	*Coffee break*
11:30 – 12:30	Lecture on 'Helium isotope dating for groundwater-surface water assessment' - Mr. P.K. Aggarwal
12:30 – 14:00	*Lunch Break*

14:00 – 15:30	Overview of country reports and discussions of local and regional issues– Mr. M.A. Choudhry
15:30 – 16:00	*Coffee Break*
16:00 – 17:30	Group discussions on common themes (issues/problems, management actions to address the problems and recommendations to the Governments and to the IAEA)

Thursday – 23 April 2009

09:00 – 11:00	Discussion on implementation of projects in the new project cycle RAS8108 (2009 – 2011)
11:00 – 11:30	*Coffee break*
11:30 – 12:30	Presentations and discussions on the output of Groups
12:30 – 14:00	*Lunch Break*
14:00 – 15:30	Discussions, working groups; preparation of report
15:30 – 16:00	*Coffee Break*
15:30 – 17:00	Discussions, working groups; preparation of report

Friday – 24 April 2009

09:00 – 11:00	Preparation of the draft meeting report
11:00 – 11:30	*Coffee break*
11:30 – 12:30	Discussions on the meeting report
13:00 – 14:00	*Lunch Break*
14:00 – 15:30	Finalization of the draft meeting report
15:30 – 16:00	*Coffee Break*
16:00 – 16:30	Closing of the meeting

Important points:

- Country reports should highlight status of water resources in the country, issues/problems in water resources development and management, common remedial actions, and adaptation/integration of isotope techniques.
- Participants should bring with them, electronically, all the presentations at the meeting.
- Participants should send a brief summary (one page) of their presentations and pdf of presentation to Mr. P.K. Aggarwal (Email: P.Aggarwal@iaea.org) Ms. Ravina Brizmohun (R.Brizmohun@iaea.org) and Mr. Manzoor Ahmad Choudhry (Email: manzoorriad@yahoo.com) at least one week before the meeting.

SUMMARIES OF COUNTRY REPORT

IAEA/RCA Executive Meeting on Application of Isotope Techniques to Solve Hydrological Problems (RAS/8/108)
Kuala Lumpur, Malaysia
20-24 April 2009

SUMMARY REPORT OF BANGLADESH

Project Title: Use of Environmental Isotopes to Study Deep Groundwater Resources in Alluvial Deposits of Manikganj District

Study Area/Problem Encountered:
Approximately 82% of the water supply for the Dhaka urban area is derived from ground water in the underlying Dupitila aquifer. Currently Dhaka WASA abstracts 425Mm^3 per year primarily for domestic water supply, while private boreholes abstract a farther 270 Mm^3 per year for domestic and industrial use. Groundwater hydrograph has continuous declining trend indicating occurrence of groundwater mining from aquifer. Groundwater depletion in the Dhaka city is occurring at alarming rate i.e. more than 3m/year at most places. Present maximum piezometric level stands at 71.39 m in upper aquifer. In order to solve this problem, government is thinking to supply the drinking water to the population of Dhaka city from the nearby sustainable groundwater sources. In this context, Singair upazila under Manikganj district is initially selected to be a well field for supplying drinking water to the Dhaka city. Singair is situated at 20 km west of Dhaka city. It is reported from the different previous studies that the shallow aquifer has arsenic concentration greater than the permissible limit (50 ppb) of Bangladesh standard.

Objectives:
- To assess the status of groundwater, especially the interconnectivity of the shallow and deep aquifer, recharge condition, age and water dynamics, etc.
- To establish the baseline data on pollutants and isotopes of surface and groundwater
- To identify aquifers with acceptable concentrations of arsenic and other constituents
- To study the pollutant behaviour and transport in river and ground water as well as the interaction between the two flow system.

Work Done:

The field sampling campaign was conducted in Singair area under Manikganj District during wet season i.e. September 2007. Total Forty-seven samples, having 38 nos. for groundwater (shallow and deep wells) and 9 nos. for surface water, were collected just after the flood. Among these, 11 nos. groundwater samples were collected from the shallow (avg. depth 130m) and deep (avg. depth 230m) monitoring wells of Dhaka Water Supply and Sewerage Authority (WASA). Twenty seven groundwater samples were collected from local hand tube well (depth range 20 -120m). Six water samples were collected from the Dhaleswari River located in the northern boundary of Singair and three water samples were collected from Kaliganga River in the southern boundary. The isotope analyses of water samples were done in PINSTECH, Pakistan.

Main Achievements:

- Baseline data on isotope and pollutant levels including metals at trace level have been developed.
- High arsenic concentrations are found mostly in the shallow groundwater (depth≈ 20-65m) of the western side as compared to the eastern side of Singair area. The two wells in intermediate depth (~120m) found with higher As concentration (98 and 122 µg/L) are located in the western side. One deep well (depth 225m) only in the western side has high Arsenic content (79 µg/L). Does it indicate that the deep aquifer is contaminated with Arsenic? From the spatial distribution of Arsenic concentration, it is presumed that there are two sub-surface water system in the Singair area.
- EC values of groundwater in western side are higher as compared to the eastern side of Singair. It indicates some geochemical reactions due to recent recharge in the western side.
- The stable isotopes (□^{2}H & □^{18}O) of groundwater fall on the Meteoric Water Line, ranging the oxygen-18 values from –3.19 to –6.94 per mil and deuterium values from –17.43 to –44.50 per mil. It indicates the recharge from the local rain and flood water with or without some evaporation effect. The oxygen-18 and deuterium values for Dhaleswari and Kaliganga river water range from –10.23 to –11.68 per mil and values from –72.82 to –82.48 per mil respectively. The river waters are highly depleted and it does not contribute to the aquifer system.
- The C-14 values of monitoring wells are in the range of 28.6 – 84.5 pMC, indicating the groundwater ages of about 1 to 10 thousand years. These are also evidenced by the low tritium values (0 - 1.72 TU), revealing the old water in the deep aquifer. Two deep monitoring wells show higher C-14 values (94.2 & 102.9) indicating the mixture between sub-modern and recent recharge.
- The Carbon-13 values of groundwater range from –2.51 to –15.15 per mil VPDB. Increasing isotope values with increasing Arsenic suggest that organic matter oxidation does not play a role in Arsenic mobilization.

Future Plan:

The following works will be done in future;

- Field investigation and collection of water samples from shallow and deep groundwater well in Sylhet district and from adjacent Surma river for chemical and isotopic analysis,
- Hydrochemical analyses of the newly collected water samples,
- Isotopic analysis of water samples for two seasons (dry and wet) is expected to carry out, and
- Preparation of GIS based map of the study area and its inventories such as wells, surface & groundwater pollutants, etc.

SUMMARY REPORT OF CHINA

Title of the Project: Isotopes and Geochemical Studies on Surface water and Groundwater Quality in Huaihe River Area, China

Study Area and Problems: The study area is in the North Plain of Huai He River (NPH) covering an area of approximately 85 000 km^2. Groundwater is the most important source for water supply in Huaihe river basin. However, the levels of shallow Quaternary groundwaters from urbanized areas have been declining continuously and groundwater quality at the urbanized and agricultural areas deteriorating in recent years. The shortage of good quality water resources becomes increasingly serious. Understanding the geochemical evolution of groundwater is important for sustainable development of water resources for Huaihe river area.

Objectives:

1. To investigate the geological and hydrological environment and fined out the regularities of the shallow groundwater aquifers, and water recharge and discharge conditions in Middle Huaihe River.
2. To find out the status of pollution, including heavy metal organic and inorganic pollution, of shallow groundwater in the study area.
3. To make a comprehensive assessment of groundwater quality between deep confined groundwater, shallow groundwater and surface water, and to predict the changes of groundwater quality.
4. Build up long term national databases after this project.
5. Disseminate results to end users through national seminars/workshops, training programmes to promote isotope techniques for pollution monitoring and investigate their water-related problems.

Achievement: During the investigations, 28 sets of water samples were collected from the study areas and analyzed for environmental isotopes of ^{2}H, ^{18}O, ^{3}H, ^{14}C, ^{234}U, ^{238}U, major chemical ions, and trace elements. The data were preliminary interpreted and progress reports were prepared.

- A better understanding of the aquifer systems in the Huaihe River area was achieved with isotope and chemical techniques.
- Infiltration by precipitation and surface water body (Wohe River, Yinghe River and Huaihe River) is the main recharge process.
- Through calibration with ^{13}C, the ages of the groundwater of deep aquifer system approximately around 1130~42450a and shallow groundwater 590~15910a from west towards east.
- The study has clearly indicated mixing of shallow groundwater and deep groundwater, the increasing trend of human activities which caused shallow groundwater aquifer has been polluted by industrial waste water discharge, city sewerage and different agriculture fertilizer effluents.
- The aquifer systems are vulnerable to contamination through infiltration from human activities, surface water and polluted shallow groundwater.

Future Work Plan:

- 25 samples will be collected for isotopes of ^{2}H, ^{18}O, ^{3}H, ^{13}C, ^{14}C and hydrochemistry of water quality and some samples for organic and inorganic material.
- The field measurement and laboratory analysis will be conducted and database

will expanded.

- Data interpretation will proceed.

IAEA Input:

- Training on interpretation of isotope data and soft-wares;
- Training on techniques for rehabilitations;
- Samples for the quality control are needed by IAEA support.

SUMMARY REPORT OF INDIA

Title of the project: Impact Assessment of Sewerage Network on the Groundwater System of Arkavathi and Vrishbhavati Basins of Bangalore, Karnataka, India Using Hydrogeology, Hydrochemistry and Environmental Isotope Techniques

Study Area/Problem: Bangalore, one of the fast growing metropolitan cities in India, is experiencing a high degree of population explosion and industrial development. As a consequence of ill -planned urban growth, the problem of water resources and pollution management have assumed greater dimension. The fact that this region did not have any perennial rivers to cater its water resources, a large number of percolation tanks were constructed in the past to augment groundwater resources for various uses. About 262 tanks dotted the region's landscape. These surface water bodies help to maintain groundwater potential in this region. But today, less than 60 tanks exist and are slowly being encroached by unplanned expansion of this growing metropolitan City.

In the absence of perennial rivers, water has to be brought to the city from long distances. This region comprises of several valleys; viz., Vrishbhavati, Arkavathi, etc. In addition to the valleys, the drains in many areas are prone to floods during rains. In other seasons, the major part of the flow is sewage and industrial wastes, which would contaminate the groundwater system. Therefore, a study has been proposed to understand the recharge and discharge processes of groundwater, water quality, impact of sewerage on groundwater system, source and origin of contaminants, etc. This will be useful to the local water managers for better groundwater utilization.

Objectives:

- Study the hydrogeology and aquifer characteristics of the area
- Establish the network for monitoring of surface and groundwater interrelation & water quality
- Establish the sewerage impact on groundwater system
- To enumerate the factors responsible for the change in water chemistry and to determine the variation in water quality in space and time.
- Generation of database for water quality parameters
- Groundwater flow and contaminant transport modelling
- Groundwater dating
- Identification of recharge and discharge areas for future groundwater development

Collaborators are: State Groundwater Board, Central Groundwater Board and Bangalore University R&D Group

Work Done/Achivements: The following techniques will be applied

- ❑ Geological and hydrogeological investigation
- ❑ Hydrochemical methods (Major and minor chemical species)
- ❑ Environmental stable and radioactive isotope techniques (^{18}O, ^{2}H, ^{13}C, ^{15}N, ^{34}S,^{3}H,^{14}C & ^{222}Rn) Groundwater flow and contaminant transport modelling

The expected outcome of the project is

- Tracing of rapid water quality changes & deterioration.
- Aquifer characterization and identification of flow direction and mixing process.
- A data base for the assessment of future demands.
- A comprehensive report will be prepared for the benefit of future investigations.

- A strategic action plan will be prepared with the help of end users for sustainable groundwater development and management.
- Propagation of isotope technology.

Future Plan:

Compilation of hydrological information & preparation of maps
Compilation of available hydrochemical data
Sampling for hydrochemistry and environmental isotopes
Analysis of hydrochemical parameters and isotopes
Aquifer characterization
Groundwater Modeling
Preparation of final report

IAEA Input Needed:

- Standards for Deuterium, Oxygen-18, Carbon-13, Carbon-14, Tritium, Sulphur-34, Nitrogen-15, CFCs
- Analytical support for these projects for environmental isotopes in case of any major breakdown of our equipments
- Software for groundwater flow and contaminant transport modelling
- Relevant Text books and Tec-docs
- Inter-comparison exercise for isotopes and chemical species
- Supply of laser analyzer for stable isotope measurements in liquid water

SUMMARY REPORT OF INDONESIA

Title of Project: Environmental Isotopes and Chemical Techniques for Improved Groundwater Resources Management at East Kalimantan, Indonesia

Problems:

- Due to fast growing of population and industries, heavy exploitation of groundwater caused decrease in groundwater budget
- Mining industries (coal and sand) and domestic wastes contribute pollutants that contaminate river and groundwater
- Deforestation and settlement cause environmental change on the recharge area

Objective:

- Interrelation between surface-groundwater, determine water balance, origin, age, evolution process, saline water intrusion.
- Determine water quality, to trace pollutant source, trace flow path of pollutant in surface and groundwater.
- Determine recharge area, simulating water balance, make recommendation base on scientific understanding for groundwater management policy

Aquifer Type:
The groundwater basin has unconfined and confined system

Expected Output:
Information on:

- Recharge area, origin, age, evolution process, groundwater balance, saline water intrusion (if any)
- Water quality data base, pollutant source, flow path of pollutant.

IAEA Input:

- ➢ Fellowship, scientific visit, expert mission,
- ➢ Stable isotope standards, parts of MSs

SUMMARY REPORT OF KOREA

Title of the project: Application of isotope technique and hydrological and hydrochemical investigation technique to solve the geogenic contamination, especially about high uranium contents of groundwater

Major Issues:

a) Water Contamination: The important reasons of groundwater contamination in Korea can be grouped in four categories.

1. Contamination by acid mine drainage gives rise to the very low pH groundwater, resulting in very high sulfate and heavy metal contents of surface water and groundwater near the acid mine area.
2. Contamination by agricultural activity is caused by excessive use of manure, fertilizer and agricultural chemicals, resulting in usually high nitrate contents of surface water and groundwater.
3. Contamination by urbanization and industrialization is caused by industrial pollution and waste, resulting in usually high nitrate and sulfate contents of surface water and groundwater.
4. Contamination by geogenic source
   - ✓ Some deep groundwater samples in Korea show high fluorine and uranium contents, which might have originated from geological environment.
   - ✓ Several groundwater samples from the drill hole in KAERI site show also high uranium contents.
   - ✓ When we sampled groundwater using double packer system based on the results of fracture analysis, the uranium contents of groundwater samples showed more clear variation with fracture distribution in the borehole.

Problems at 1, 2, 3 and 4 can be controlled by technical treatment and regulation, but 4 (geogenic contamination) is difficult to be controlled technically. Therefore development of techniques is required to investigate and evaluate the geogenic problem, which includes combination of hydrological investigation and hydrochemical investigation (isotope application).

b) Water Shortage

c) Flood Damage

Objective

Application of isotope technique and hydrological and hydrochemical investigation technique to solve the geogenic contamination, especially about high uranium contents of groundwater

Study Site: KAERI site (northern part of the Yuseong area)

WHAT WE NEED FROM IAEA

- ➢ Standards for isotope analysis: Tritium, O-18, Deuterium, S-34, C-13
- ➢ Comparison of the isotope analysis between the member countries
- ➢ Fellowship or training about the interpretation (geochemical modeling) of isotope and hydrochemical data

SUMMARY REPORT OF MALAYSIA

Title of the project: To assess the trend of freshwater quality in Langkawi Island

Study Area/Problem: The study on the hydrogeology of Small Island of Langkawi was performed from 1994 to 1995 in order to study and characterise the aquifer system and to evaluate the groundwater quality. The study showed that the overall quality of the groundwater was generally good and suitable for drinking and irrigation. However, the high iron concentrations were found in the Singa Formation and the alluvial aquifers. The bicarbonate type groundwater with higher calcium contents was also found in the limestone aquifer in the Kisap area (part of the Singa Formation). The study also found that the groundwater in the Malacca River Basin had higher sodium content.
Due to rapid development on the island, the future water demand will increase. Groundwater will become extremely important as a supplementary source of water supply on the island when surface water availability is insufficient to meet the increased water demand. Therefore, a major reason for this study is to look into the trend of groundwater quality in Langkawi Island because of fear of groundwater contamination from point and non-point pollution sources.

Objectives:
1. To assess the trend of freshwater quality in Langkawi Island by comparing the previous data in 1994 and recent data by using isotope techniques intergrated with conventional geological, hydrogeological and hydrochemical techniques;
2. To establish regional network of surface water and groundwater for water quality parameters comprising isotope and chemical constituents;
3. To investigate surface water-groundwater and inter-aquifers hydraulic interactions;
4. To trace pathways of contaminant migration in surface waters and groundwaters;
5. To expand baseline database of isotopes and chemical constituents developed under the project RAS/8/097;
6. To make recommendations and formulate an appropriate water resources management policy, preventive measures and mitigation alternatives as necessary that will control surface and groundwater pollution.

Work Done/Achievements: This study involved only technical aspect consists of isotope techniques as well as geological, hydrogeological and hydrochemical approaches to identify evidence of pollution occurrence, the sources of pollutants and to assess changes in surface water and groundwater quality. The research finding recognise that

i. Major contributor of the water resources in Langkawi Island only comes from precipitation
ii. The recharge of groundwater in Langkawi Island can also be contributed from surface water and vice versa
iii. The age of groundwater in that area is of sub-modern to modern (0.5 TU- 2.39TU) and quite sustainable
iv. The elements of Sodium and Fe III are relatively higher and the concentration of these elements are above the maximum permissible limits as specified in the Malaysian Drinking Water Standard of the Drinking Water Quality Act 2001
v. Even though the concentration of Chloride is relatively higher but it still below the maximum permissible limits as specified in the Malaysian Drinking Water Standard of the Drinking Water Quality Act 2001

IAEA INPUT: Isotope analytical service for C^{14} and tritium.

SUMMARY REPORT OF MYANMAR

Title: Overview of water problems in the country

Introduction:

Myanmar has various sources of water supply including rivers, streams, lakes, ponds etc. We have good freshwater environment in general although there are some regions where drinking water, which is conductive to live is still scare. Freshwater, resources are essential for human survival, agricultural, economic and industrial activities. The government is undertaking tasks, one of which is to supply potable water for rural development. Environmental protection programs also include environmental policy.

Population in Myanmar has been increasing year by year. Increasing urbanization and industrialization are the main culprits responsible for contamination of natural water. Both long-term and short term plans are also being carried out for rural and urban water supply that is to make available of clean water for regional development.

There are still on-going projects for implementation for better fresh water environment in the country. Control water quality is a joint work of various ministries in our nation under control of laws, rules and regulation for protection of air and water pollution. Wastewater treatment plant project has been upgraded since 2006. I will send the study area after submission officially when I arrive my country. According to our official process, I will be going to continue the project after getting permission.

Objective: The objective is to take part in the maintenance and establishment of freshwater environment in the country.

Future Plan: At the present time, isotope techniques are not yet widely used in practice and we have not sufficient facilities for isotope analyses and also lack of sufficient training for field hydrologists in the use and application of isotope techniques. In addition, we have necessary appropriate university curricula and post-graduate training courses in isotope hydrology. However, this technology is going to be used in future.

SUMMARY REPORT OF PAKISTAN

Title: Water Resources of Pakistan – Current Issues and Way Forward

Water Resources: Water is the major driving force and engine for the irrigated agriculture and economy of Pakistan. The Water Resources of Pakistan are rainfall, river flows and groundwater. The rainfall is uncertain and sporadic in nature. The canal flows are insufficient to fulfill crop water requirements. As such these supplies are augmented through groundwater exploitation. Agriculture sector uses over 90% of water and contributes 24% of GNP and employs 80% of labour force in the rural areas and almost 50% at the national level.

The total canal supplies were 52.6 MAF during 1960-61 and the irrigated area was 25.7 MA. The construction of storage reservoirs enabled Pakistan to acquire significant capability of river flow regulation. By dint of storage facilities, canal head diversions progressively increased. At present the irrigation system of Pakistan is utilizing a total of 105 MAF of water to irrigate an area of 36 MA. The increase is attributed to the storage reservoirs of Mangla, Chashma and Tarbela. Tarbela and Mangla are multipurpose water projects contributing towards economic development of Pakistan. The controlled water supplies enhanced water diversions that have contributed to increased agriculture production. However, due to spatial and temporal variations in river flows across seasons / years necessitates additional construction of reservoirs to optimally use available flows for agriculture and other competing sectors.

The growing imbalance in supply and demand of water for agriculture and other sectors is felt acutely. Groundwater is also exploited to the tune of over 4o MAF to fulfill the crop water demand and other requirements. Population growth, rapid urbanization, industrialization and environmental degradation are imposing more pressure on water resources. To meet these challenges WAPDA has prepared a development programme known as Vision 2025 Programme for Water Resources and Hydropower Development. Kalabagh Dam is a component of this programme, which is ready for construction for the benefit of the country after provincial harmony. The project would provide irrigation water to meet the demand of food production and cheaper electricity. Water sector of Pakistan is the largest enterprise contributing to the tune of over Rs. 30 billion per annum to the national economy through agriculture sector.

General Issues: The water resources of Pakistan are scanty but the system losses are very significant. This needs integrated water management to reduce the irrigation system losses. The evaluation of seepage through reservoirs and irrigation system is investigated using several techniques including Isotope Technology. Besides this, regular river water quality monitoring is required. The over mining of aquifers is creating saline water intrusion into fresh water to pollute it. The surface water streams are also being polluted by municipal, industrial and drainage effluent. Water treatment is necessary. Under vital collaboration with PINSTECH, WAPDA can undertake certain programme of isotopic investigations requiring less time, cost effective as well as reliable results for new water sector projects as baseline.

Title of Ongoing Project: Investigation of interaction between Indus River and groundwater around proposed Kalabagh Dam site

Problems:

- Expected water logging and salinity problems in the surrounding areas of dam reservoirs
- Contamination of Indus River with industrial effluent, agricultural activities and urban sewage.
- Movement of contaminants from surface water to groundwater

Specific Objective:

- To study water quality parameters of the river Indus, its tributaries and groundwater in the surrounding areas from Attock to Kalabagh.
- To investigate surface water groundwater interactions.
- To trace pathways of contaminant migration in surface waters and groundwaters.
- To contribute in establishment of regional network of surface water and groundwater for water quality parameters comprising isotope and chemical constituents.
- To make recommendations, based on scientific understanding, for water resources management policy, preventive measures and mitigation alternatives as necessary.

Preliminary Conclusions:

- Groundwater is mainly recharged by rain water
- River Indus does not have any significant contribution in the groundwater recharge upstream of Kalabagh City
- The river has dominant contribution in groundwater recharge in the area on the left bank and downstream of Kalabagh.

New Projects: PINSTECH and WAPDA have planned the following new studies of national interest using isotopes techniques.

- Establishment of baseline data and study of seepage effect on ground water from:
  - Greater Thal Canal
  - Rainee Canal
  - Kachhi Canal
- Study of effect of Diamer Basha Dam on surrounding valleys.

SUMMARY REPORT OF PHILIPPINES

Title: Philippine Country Report

Water has always been and will continue to be an essential natural resource in the development of the country. In the Philippines, the National Water Resources Board (NWRB) is the government agency tasked in coordinating and regulating all water resources management and development activities in the country.

Given an annual rainfall of 2,400 mm, 421 principal rivers and extensive groundwater reservoir, the country is theoretically assure with abundant supply of water. It is estimated that the country has groundwater potential of around 20,200 MCM/year and about 125,790 MCM/year of available surface water at 80% dependability. However, because of seasonal variation and geographic distribution, water availability varies among regions. Increasing pressure on freshwater resources by rapid population growth and increasing economic development also resulted in a number of regions and at least nine key urban centers experiencing water stress. Region 3 and 4 is currently experiencing water deficit while region 2 and 5 is now facing future water deficit. Furthermore, usable water is becoming limited due to contamination and pollution. It is reported that only one third (36%) of the country's river systems are potential sources for drinking water while around 50 rivers (12%) of the 421 rivers in the Philippines are considered biologically dead. Preliminary data also indicates that up to 58% of groundwater sample intended for drinking water supplies are contaminated with total coliform. Saline water intrusion near the coastal areas which is caused by over-exploitation or excessive withdrawal of groundwater is also being observed. Aside from this water resources issues the Philippines is also confronted with water resources management and development issues and challenges that hinders sustainable development of the country's water resources.

In order to address the above mentioned water issues the Philippines through NWRB continuously conducts water resources assessment as a decision support tool in planning, policy formulation and water allocation. Water allocation and conservation policies were also formulated especially in identified critical areas. As provided by the Clean Water Act, Water Management Areas were identified and Groundwater Vulnerability Mapping for water quality and quantity is currently being proposed.

The use of isotope techniques is now seen as a tool for water resources management. The Philippine Nuclear Research Institute is currently spearheading the awareness and utilization of isotope techniques in fresh water resources management under the IAEA/RCA Project RAS/8/104. As part of the Philippines activities under this project, a National Executive Management Seminars in the end-user departments was conducted in December 2007. A collaborative activity on possible application of isotope techniques in assessing water resources through a MOA is currently being proposed between PNRI and NWRB.

To realize the objective of the project RAS/8/104 in extending awareness and utilization of isotope techniques on freshwater resources management, assistance is needed in training end-user specifically on data sampling, analysis including its application in Hydrology.

SUMMARY Report OF SRI LANKA

Project Title: Investigation of the Trends in Water Quality Deterioration of Northwestern Limestone Aquifer System of the Puttalam District of Sri Lanka; the Groundwater Source of Puttalam Urban and Rural Water Supply Schemes

Study Area/Problem: Due to the rapid expanding and intensifying urban, industrial and agricultural activity, groundwater extraction and use is significantly increased in recent past. In the Puttalam District of Sri Lanka at Northwestern Limestone aquifer system, deep borehole construction for groundwater exploration and exploitation ware commenced since 1970s and now operate over 1000 of tube wells for various water supply schemes. Among them, Puttalam Town Water Supply Scheme can be identified as one of the most important public water supply schemes. . The aquifer system is associated with complex Carbonate aquifer conditions of highly caverness Sedimentary Limestone formations and lie as different layers that those inter-bedded with sandstone and other unconsolidated deposits such as thick clay layers, sand and sandy clay. Thickness of limestone aquifers from 25 m in the east to about 150 m depths below ground level in the west coast. It is also confined into some extent.

Objectives:
It is emphasized to conduct a detailed hydrogeological and hydrochemical assessment aiming identification of the magnitude and mechanism of saline intrusion and the other causes of water quality deteriorating in the area to recommend the mitigating measures. The other objectives of the study are to determine the origin of saline water within the different subsurface water bearing layers, estimate the degree of mixing and salt water fluxes, identify the characteristics of major flow paths, establish the network for monitoring of surface and groundwater interrelation & water quality and Generation of database for water quality parameters

Work Done/Achievements: There is no proper study previously done.

IAEA Input Needed:

1. Expert assistance for isotope analysis, data interpretation and compilation
2. Equipment necessary to conduct accurate sampling including depth samplers etc.
3. Chemicals and other support necessary for sample analysis at the laboratories of Water Resources Board (WRB) and AEA of Sri Lanka.
4. Necessary software and other subject materials relating to the proposed study.
5. Training on the Subject

Future Plans: Sri Lanka has recently experiencing epidemic level health problem of Renel Kidney failures (RKD) in the regions of Dry Zone which covers about 40% of total area of the country. These areas had been a part of the highly irrigated very old (1000's of years) agricultural civilization. Thus the area is full of man made reservoirs while were fed by rain until recently, without any record of health hazards.

Recently however with a combined situation of abandoning of rain fed reservoirs and bringing water from Mahaweli project of hill country plus heavy use of agrochemical, the people in the area are reporting RKD. Blame is obviously laid on polluted water.

It is proposed to have a coordinated study of real sources of pollution, using Isotope technology. IAEA support is required preliminary in designing and formulating the study.

SUMMARY REPORT OF THAILAND

Project Title: Application of Isotope Hydrology for Solving Nitrate Genesis in Groundwater, Northeastern Part of Thailand

Northeastern part of Thailand is a barren land and plateau terrain coverage one third of the country in area. In the past decades of groundwater development indicated that water quality in some areas has more nitrate content over drinking standard and an account of 5-10 percent of pumping wells. Recently, there are not any definitely evidences to imply the sources of nitrate. The previous study concluded that the sources should be ideally from human activities- such as septic tank leakage or using fertilizer for their agricultures. High nitrate content in groundwater is mostly ranging from 50- 200 mg/l but in some areas up to thousand.

In 2009, Department of Groundwater Resources or DGR has established the project on "Application of Isotope Hydrology for Solving Nitrate Genesis in Groundwater, Northeastern Part of Thailand" in order to crucially study the sources of nitrate by using isotope technique. The first step has been already done that is 1,000 random water samplings in the areas of previous known for high nitrate and analyzing some chemical elements. The early results show that many villages have high nitrate over 50 mg/l in groundwater pumping wells at 20-60 meters in depth. Some areas have nitrate content more than 1,000 mg/l. Hydrogeological conditions are mostly identified as loess, sandstone and shale of Cretaceous/Tertiary sedimentary rocks-Phutok Formation and Jurassic sedimentary rocks-Phu Kradung Formation.

In the next steps, groundwater will be intensively collected in the selected areas for isotope analyzing. In terms of isotope technique, many isotope elements are mainly consisting of $\delta^{15}N$ and $\delta^{18}O$, $\delta^{2}H$ and $\delta^{18}O$ and C-14. The directions of isotope interpretation will follow the nitrate diagram for solving nitrate genesis, groundwater age and groundwater flow. Expected results should be reasonable explanation for the sources of nitrate in groundwater of Northeastern part of Thailand in the future. However, the successful project must directly depend on instruments and efficiency of isotope analyzing from Thailand Institute Nuclear Technology or TINT.

Requirement from IAEA: DGR need to setup some simple practical isotope instruments in the laboratory or their Spec due to TINT can not serve isotope analysis for DGR targets on time.

SUMMARY REPORT OF VIETNAM

Project Title: Use of Isotope Technique for Solving Hydrological Problem in Hochiminh City, Vietnam

Study area and water resource problems: With a population of appropriate 8.0 millions and economic developing rate of about 10.5% (2008), water resources in Hochiminh City is facing with some problems such as the exhaustion of groundwater sources and relevant problems (increase in groundwater pollution; land subsidence); Groundwater quality is influenced by producing and living activities; and the decline of water quality of Saigon river, the main surface water source in the study area.

Specific objective: For better management of water resources in the area, some studies using isotopic and chemical techniques have been set up to solve some hydrological problems addressed.

Specific objectives of studies are use of isotopic and chemical techniques to i) Assess contamination status of groundwater and Define the source of contaminant, ii) Investigate the modern recharge possibility (sources, regions) of groundwater system iii) Predict water source contaminated risk and also to expand isotopic and chemical database initiated under the last RAS projects.

Studies being done: To define the source of nitrate in groundwater, a sampling network has been set up for collecting water from all existing aquifers and also from main source of surface water in study area. Water samples have been analyzed for nitrate, liquid-water stable isotopes, $\delta^{15}N$ and $\delta^{18}O$ (in nitrate). Nitrate concentration of water samples collected has been used to assess contaminated state of groundwater and to map the distribution of nitrate in groundwater while $\delta^{15}N$, $\delta^{18}O$ (in nitrate) are used to define the source of nitrate. Chemical analysis data of water sampled show that in some places, groundwater is contaminated by nitrate with concentration is up to 120 mg/l. Primary analysis data of groundwater samples on $\delta^{15}N$, $\delta^{18}O$ (in nitrate) show that nitrate in groundwater originated from soil organic matter, septic waste, manure and also from nitrogen mineralized fertilizer. Source of nitrate in groundwater needs to be defined more detail.

To evaluate the risk of shallow groundwater contaminated by nitrogen fertilizer used in agricultural activities, urea fertilizer enriched in ^{15}N isotope and ^{131}I are using as tracers to follow the penetration of nitrogen fertilizer and water used in vegetable cultivation in Hochiminh City. ^{15}N concentration and ^{131}I activity in soil depth can show the possibility and infiltrating rate of nitrogen compound of fertilizer and water from soil surface to shallow groundwater. This field experiment is still on going.

To estimate the effluence of soil eroded on Saigon river water quality, ^{137}Cs technique has been used to rate the soil erosion in a part of the river basin. Total amount of Fe and Mn in soil eroded can be calculated based on their concentration in soil surface samples. In supposing that total amount of Fe and Mn in soil eroded dissolve and come into the river, their contribution in Fe and Mn concentration of river water can be evaluated. This study needs to be enlarged for whole river basin.

Input from RCA/IAEA:

- Consumable and spares for isotope analysis in water by LGR Liquid-Water Isotope Analyzer: i) Air Dryer w/connector kit: 2 pcs; ii) 1.2µl syringe: 3 pcs; iii) Measuring vial (2ml volume) and vial cap (pck of 100): 10 pkgs; iv) 10µl Septum Inlet Filter: 4 pcs; v) Working Standard Set including 5 standards from WS1 to WS5: 3 sets.

- RCA/IAEA technician/ expert for maintaining, regulating and standardizing instruments.

Annex-4

RAS/8/108 EXECUTIVE MEETING PHOTOGRAPHS

Addresses of Mr. Mohd Noor Bin Mohd Younus, Chief Guest (Deputy Director General, Malaysian Nuclear Agency) and Mr. Manzoor Choudhry in Inaugural Cermony

Group photo of the meeting participants with the Chief Guest

Presentation of Project Overview by Manzoor Choudhry

Participants of the meeting during a presentation

A lecture by Mr. Pradeep Aggarwal, Head Isotope Hydrology Section, IAEA

Participants discussing common themes in two groups

Visit of Isotope Hydrology (Mass Spectrometer) Lab. at NMA, Bangi

Group photo of the participants with Mr. Aggarwal