

MINISTÉRIO DE MINAS E ENERGIA
SECRETARIA DE GEOLOGIA, MINERAÇÃO E
TRANSFORMAÇÃO MINERAL

CPRM – SERVIÇO GEOLÓGICO DO BRASIL

RELATÓRIO DE VIAGEM AO EXTERIOR

Viena, Áustria



“First Research Coordination Meeting (RCM) of the IAEA CRP on “Isotopic assessment of the impacts of climatic and hydrological changes on wetland-groundwater ecosystem interactions”

Promovido por Agencia Internacional de Energia Atômica (AIEA)

ROBERTO KIRCHHEIM

JUNHO DE 2022

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Viena, Áustria

“First Research Coordination Meeting (RCM) of the IAEA CRP on “Isotopic assessment of the impacts of climatic and hydrological changes on wetland-groundwater ecosystem interactions”



Foto: Grupo de pesquisadores envolvidos em projetos de aplicações isotópicas a *wetlands* em cooperação com a AIEA.

Roberto Eduardo Kirchheim

Data: 10/2022

Capa: Logo do Grupo de Pesquisa em Isótopos e Wetlands

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I – Introdução

A viagem técnica, objeto deste relatório, foi realizada para a sede da AIEA em Viena Áustria entre os dias 13 e 24 de Junho de 2022. A programação técnica da mesma é caracterizada por dois momentos, uma jornada técnica e uma jornada estratégica prospectiva institucional.

A jornada técnica está relacionada à reunião denominada de “First Research Coordination Meeting (RCM) of the IAEA CRP on “Isotopic assessment of the impacts of climatic and hydrological changes on wetland-groundwater ecosystem interactions”, na qual o SGB participa como convidado por ter sido contemplado com o projeto - Multitracing Techniques assesment on understanding the water dynamics in the Wetlands ("Pantaninho") of the Tietê River Basin, Brazil. Trata-se de projeto elaborado e proposto pelo Programa de Isotopia Aplicada à Hidrologia da DHT-SGB e que foi ganhador de recursos de cooperação (mecanismo tipo Coordinated Research Project - CRP) em edital internacional. O convite formal e nominal foi destinado ao líder técnico do projeto, conforme pode ser apreciado no **Anexo I**.

A liberação formal da viagem encontra-se expressa na publicação do Diário Oficial conforme consta no **Anexo II**.

A agenda da referida jornada encontra-se no **Anexo III** e os participantes da jornada estão listados no **Anexo IV**.

A participação nesta reunião é mandatória e de suma importância para os representantes de projetos aprovados. Juntamente com expertos da AIEA e pesquisadores de outros grupos estrangeiros, todas as diretrizes e alinhamentos do referido projeto serão abordadas e definidas. Os benefícios para o SGB são expressivos e palpáveis e poderão ser apreciados na correta condução da execução do projeto e nas múltiplas possibilidades de trocas e intercâmbios com outros centros de pesquisa. Todas as informações recebidas e aportadas no decorrer da jornada serão imediatamente compartilhadas com toda a equipe nacional do SGB.

A AIEA se responsabilizou em pagar o custo da participação do representante do SGB nesta jornada, conforme explícito no **Anexo I**.

A jornada de caráter estratégico institucional se estendeu entre os dias 20 a 24 de junho e ocorreu na própria sede da AIEA em Viena. Diversas reuniões com as lideranças técnicas dos setores de hidrologia e urânio da AIEA foram realizadas. De forma semelhante ao que foi conquistado nas aplicações isotópicas na hidrologia, em cujo tema o SGB foi alçado a Centro Colaborativo da AIEA, busca-se abrir caminhos para as demais áreas sinérgicas entre ambas as instituições, a começar pelo Programa de Uranio da DGM-SGB. As referidas reuniões e resultados específicos serão descritos a seguir.

II– Objetivos da Viagem:

Foram dois os objetivos principais da viagem. O primeiro, de caráter mandatório, foi o de participar da reunião de coordenação e execução do CRP citado haja visto a aprovação da proposta do SGB junto ao setor de cooperação da AIEA. O segundo objetivo teve caráter estratégico e seu propósito foi consolidar a posição de pioneirismo e vanguarda do SGB nas práticas isotópicas na hidrologia, assim como abrir os caminhos para uma maior participação do SGB nas questões e oportunidade em torno do Urânio.

III – Assuntos Tratados

A – Reuniao Técnica do CRP

A reunião técnica do CRP seguiu rigorosamente a agenda preliminar exposta no **Anexo II** e contou com a participação dos pesquisadores conforme o **Anexo III**.

Neste contexto, destaca-se os seguintes momentos da jornada:

- a. Apresentação das propostas e projetos de cada grupo. O SGB apresentou o projeto sumarizado nos **Anexos V e VI**. Todos os grupos de pesquisa fizeram suas apresentações seguido de ampla discussão em torno de similaridades e sinergias possíveis entre os grupos.
- b. Discussão consensuada em torno das técnicas e metodologias a serem usadas por todos os grupos de pesquisa em seus *wetlands*. Desta forma, assegura-se que todos os grupos usem um conjunto de técnicas comuns e assim, poderem comparar resultados e realizar discussões em conjunto.
- c. Desenvolvimento de cronograma de trabalho para os 03 anos de execução dos projetos e discussão em torno de permutas de equipamentos e intercâmbios entre os grupos.



Figura 1. Fotos da dinamica do CRP com as apresentações do SGB e foto do representante do SGB com a Coordenadora da AIEA em frente à entrada principal da sede da AIEA em Viena.

B – Jornada de Reuniões de Caráter Estratégico

Nesta segunda etapa, foram realizadas uma série de reuniões com líderes e tomadores de decisão da AIEA e Corpo Diplomático Brasileiro em torno dos assuntos de isotopia na hidrologia e urânio. A seguir far-se-á relato de cada uma das reuniões.

- i. Reunião com o Oficial Coordenador da Rede GNIP Mundial – Stephen Terzer (AIEA)

Definição das dinâmicas e calendário de funcionamento da Rede GNIP no Brasil e operada majoritariamente pelo SGB através do Programa de Isotopia da DHT. Estão em curso novos pontos de coleta para complementar a rede nacional e faz-se necessário consultar a AIEA e avaliar se os mesmos terão apoio analítico, da mesma forma como vem ocorrendo com as demais estações GNIP. Estão em pleito estações em Santana do Livramento, Petrópolis, Criciúma, Boa Vista, Rio Branco, Abrolhos e Fernando de Noronha. O Brasil é reconhecido pela

AIEA por ter ofertado a comunidade científica um dos mais ricos acervos isotópicos, a escala continental. A pauta com Terzer também incluiu cronogramas de eventos sobre isotopia de água de chuva no Brasil para 2023.

ii. Reunião com a Oficial da Rede GNIR e Wetlands – Lucia Ortega (AIEA)

São muitos os projetos com a AIEA que precisam ser coordenados em termos de sua logística de coleta, equipamentos e apoios analíticos. A Oficial Lucia Ortega é responsável pelos programas com aplicações isotópicas para América Latina. Foram discutidos os seguintes temas:

- Status dos atuais CRP's em curso entre AIEA e SBG;
- Cronograma de envio de amostras coletadas em 2022 para AIEA;
- Solicitação de referências para aquisição de Medidores de Radônio e Extratores de gases;
- Consulta sobre apoio para realizar análises de ^{14}C .

iii. Reunião com Oficial Radioisótopos – Takuya Matsumoto (AIEA)

Discussões em torno das coletas de Gases Nobres e ^{81}Kr no SAG em complemento às amostras realizadas no CRP passado (tese de doutorado de Roberto Kirchheim). Da mesma forma, foram consultados os mecanismos para empréstimo por parte da AIEA do espectrômetro de campo para gases nobres, o qual pode ser disponibilizado pela AIEA para apoio aos estados membros.

iv. Reunião com Oficial Responsável pela Cooperação Técnica com Brasil – Dominika Zahrer (AIEA)

A reunião com a Oficial Dominika foi essencial para estreitar os laços e para que a mesma conhecesse o trabalho e áreas de atuação do SBG e suas interações com a AIEA. O SBG foi apresentado, sua missão, suas diretorias e os programas com interface direta com a AIEA, isotopia e uranio. Pelo seu desk passam todas as propostas e submissões que o SBG concorre. De forma específica, foram consultados os passos para que o SBG participe de forma mais ativa das atividades relacionadas ao uranio. Foi traçado um caminho crítico para que pesquisadores do SBG possam receber as bolsas da AIEA para participar de curso sobre práticas em uranio (prospecção e mitigação) na instituição de referência denominada DIAMO na República Tcheca.

- v. Reunião com Oficiais Responsáveis pelo Programa de Urânio – Brett Moldovan (AIEA) e Mark Mihalasky (AIEA)

Na companhia de colega do SBG em fellowship na AIEA (Felipe Tavares) foi realizada reunião com Brett e Mark no sentido de entender os mecanismos para aumentar a presença do SBG nas iniciativas sobre urânio. Fez-se o pleito para que Felipe Tavares e Roberto Kirchheim fossem nominados para comporem a comissão organizadora oficial do Evento URAM23, a ser realizado em 2023 em Viena na sede da AIEA.

- vi. Reunião com Diretora de Isotopia Aplicada a Hidrologia – Jodie Miller (AIEA)

A diretora do setor de isotopia da AIEA começou seu mandato há poucos meses e era importante apresentar as interfaces atuais entre SBG e AIEA. Da mesma forma, foram discutidos aspectos estratégicos de médio a longo prazo.

- vii. Reunião com Missão Permanente do Corpo Diplomático Brasileiro junto a AIEA (Embaixador Carlos Sérgio Sobral Duarte e Embaixador Adjunto Gustavo Martins Nogueira)

Esta reunião é de fundamental importância e consolida a agenda positiva do SGB perante a AIEA. Os benefícios para o SGB irão traduzir-se em mais oportunidades de intercâmbios e apoio financeiro da AIEA ao SGB, o que vem maciçamente acontecendo nas aplicações isotópicas.

Foi discutida também a contribuição que o SGB-Assuni forneceu ao Corpo Diplomático Brasileiro para compor o Technical Cooperation Report da AIEA para 2021. A contribuição foi elogiada e considerada de extrema relevância.

As a successful example of institutional partnership and dissemination of nuclear isotopic techniques in the generation of hydrological information, is worth to mention the case of the Geological Survey of Brazil (SGB-CPRM) and its program of isotopic applications in hydrology. The SGB-CPRM and the IAEA formally signed the international agreement that recognizes the SGB as a Collaborative Center (CC) of the IAEA for the dissemination of isotopic techniques applied to water resources nationwide and also continentally. The execution of the work plan of the aforementioned Agreement generated significant results, such as: the expansion of the isotopic rainfall monitoring network to up to 21 GNIP stations and the execution of isotopic assessments of rivers, within the GNIR Program, in two strategic pilot basins (Basin Taquari-Coxins River and São Francisco River Basin) involving more than 300 water

samples. The participation and involvement of the SGB in the research and exchange mechanisms promoted by the IAEA, such as CRP's, has been decisive in enhancing the water resources knowledge. As an example, throughout CRP mechanisms, researchers from the SGB-CPRM and UNESP joined together with AIEA experts in the application of pioneering groundwater dating techniques based on ^{81}Kr and ^4He in the Guarani Aquifer System, recognized as one of the largest and most important transboundary aquifers in the world. Residence times achieved more than 500,000 years, turning out to be highly demanded and strategic information with significant impacts in the groundwater management policies. This is a pioneering study in the world that was only possible given the support of the IAEA. The CC status achieved by the SGB-CPRM was a triggering factor for institutional strengthening of the SGB-CPRM, allowing the institution to participate in research projects and capacity building activities raising its capabilities to take over more responsibilities in generating more value in the overall information in water resources.

The demand for clean energy in Latin America and the Caribbean is continuously growing. Nuclear energy production is one of the most viable options as it is safe, of low cost, with perennial availability and accessible technology. Nuclear energy is also fully supported by Sustainable Development Goals No. 7 (Accessible and clean energy) and No. 13 (Climate Action). In this context, the inventory and evaluation of the availability of uranium resources, the primary raw material that feeds the nuclear fuel cycle, is essential for the adequate development of national or regional public policies related to the subject. The SGB-CPRM has made regarding the generation of Uranium favorability and anomalies maps through the use of geophysical data and the use of machine learning techniques. The region represents around 14% of the world's emerging lands. However, only 4.3% of the primary uranium deposits of the UDEPO base (Uranium Deposit Database) of the International Atomic Energy Agency - IAEA are found in Latin America. Such a discrepancy does not reflect a low potential for the occurrence of deposits, but an under explored geological environment, with a high potential for discovering new nuclear mineral resources, especially those with low production costs. Thus, it is essential to add new data to the national, regional, or inter regional databases of mineral deposits and develop the mineral potential modeling to define favorable areas for the future discovery of new deposits. This is an area where the SGB-CPRM may have an expressive contribution and is willing to cooperate with the AIEA more intensively.

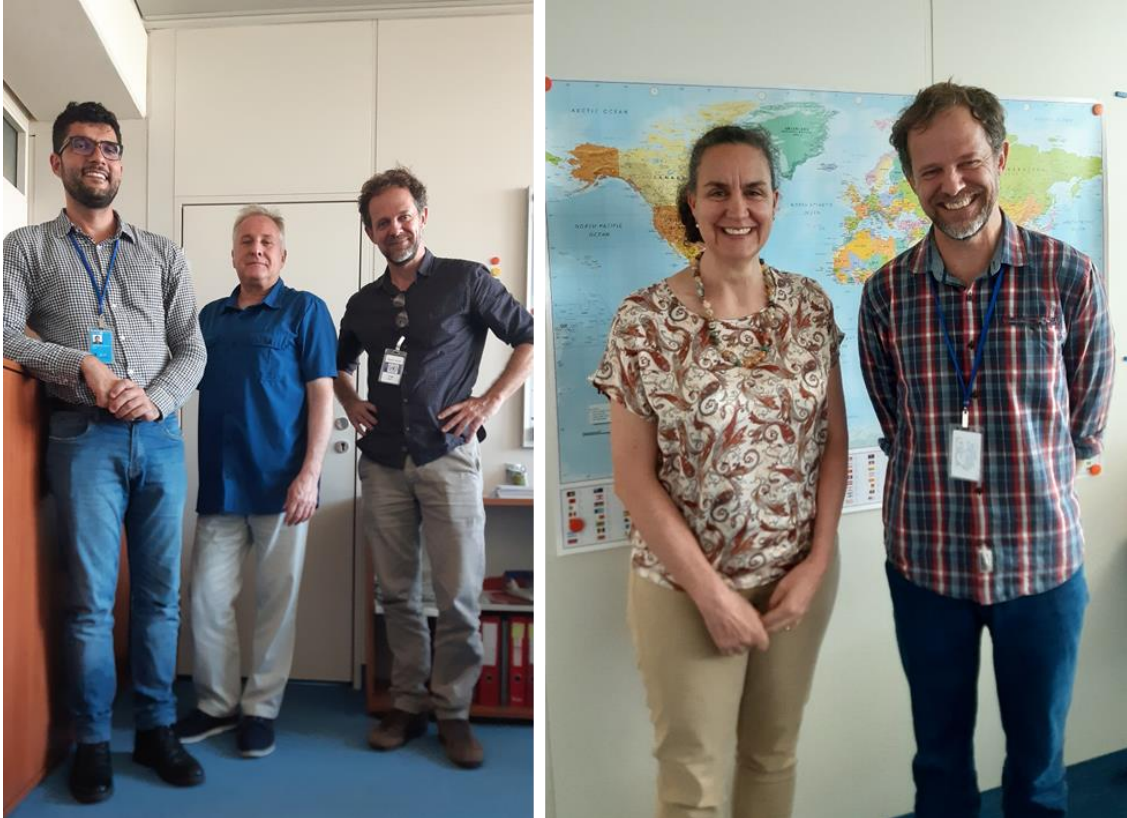


Figura 2. Reunião com Felipe Tavares (SGB e atualmente em *Fellowship* na AIEA e Mark Mihalasky (AIEA) e Reunião com Jodie Miller (AIEA)

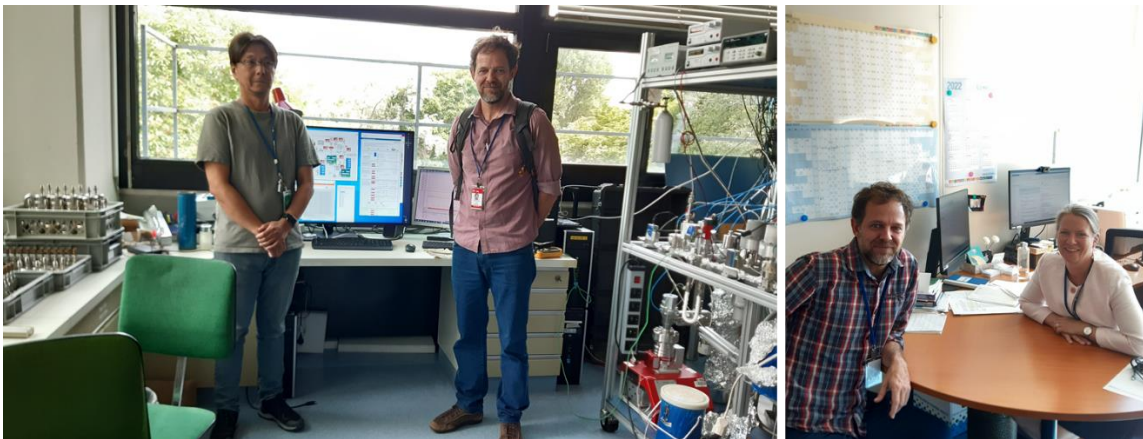


Figura 3. Reunião com Takuya Matsumoto (AIEA) e Reunião com Dominika Zahrer (AIEA).

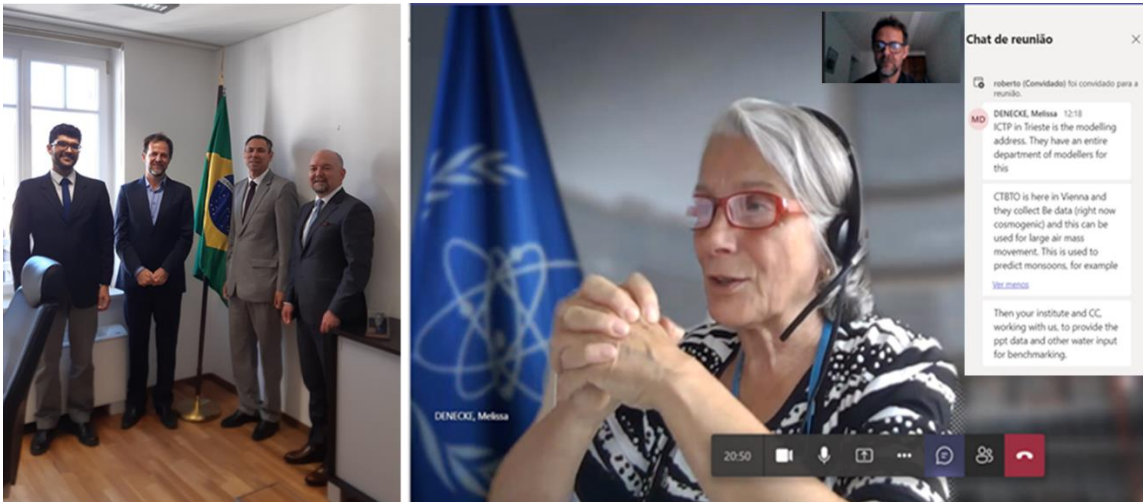


Figura 4. Reunião com corpo diplomático do Brasil junto a AIEA (Embaixador Carlos Sérgio Sobral Duarte e Embaixador Adjunto Gustavo Martins Nogueira) acompanhado de Felipe Tavares (SGB e *Fellow* AIEA) e Reunião Virtual com Melissa Dannecke (AIEA)

IV – Conclusões

- ✓ É notável o reconhecimento que a CPRM vem adquirindo ao longo do percurso de aplicações isotópicas na hidrologia. Esta situação, somada às características intrínsecas de capilaridade da CPRM e sua alçada à instituição de pesquisa científica e tecnológica, oferecem uma oportunidade única da CPRM assumir o papel de protagonista em estudos isotópicos aplicados à hidrologia;
- ✓ Os resultados práticos da articulação institucional com CNEN e AIEA que sendo conduzida pelo SBG, a exemplo desta missão, são contundentes:
 - O SBG foi aprovado para executar CRP em isotopia aplicada a *wetlands*, pesquisa inédita no mundo. Uso de métodos multitraçadores complementado por hidroquímica, geofísica, uso de drones, sensoriamento remoto e hidrologia. Recursos disponibilizados pela AIEA na forma de repasse financeiro e análises químicas R\$ 200.000,00.
 - A colaboradora Isadora Kuhn foi aprovada pela AIEA para passar um ano de seu período doutoral trabalhando nos laboratórios da AIEA na forma de *Fellow*.
 - Os colaboradores Roberto Kirchheim e Felipe Tavares foram formalmente nominados representantes do seletor grupo de coordenadores do URAM23, a ser realizado em Viena em 2023.
 - Os colaboradores Idemberg Macedo e Hugo Polo foram aceitos pela AIEA para participar em jornadas técnicas específicas

relacionadas ao monitoramento de contaminação radiogênica em Viena.

- O SBG teve proposta de cooperação para o Biênio 24/25 aprovado pela AIEA. São R\$ 650.000,00 sem repasse financeiro e na forma de aquisição de equipamento e pagamento de fellowships e viagens científicas em benefício do programa de isotopia.
 - Abriram-se caminhos para indicar nomes de representantes técnicos do SBG para participarem de curso na renomada instituição DIAMO da República Tcheca com custeio integral coberto pela AIEA. O curso ocorre em 2023 e tem duração de 01 mês abarcando todos os aspectos da prospecção, mineração e remediação de minas de urânio.
- ✓ O fato do SBG ser um Centro Colaborativo da AIEA na isotopia abre portas valiosas, entre elas, a possibilidade de realizar Capacitações e *Fellowships* em investigação isotópica, aumentando e melhorando sobremaneira as competências técnicas no SBG.
 - ✓ A mesma estratégia adotada para as aplicações isotópicas deve ser perseguida nos assuntos relacionados ao urânio. Esta missão foi um primeiro e importante passo neste sentido.

V – Recomendações

- ✓ A cooperação entre a CPRM e a AIEA é um caminho de ganhos mútuos. A CPRM muito se beneficia deste apoio ainda mais considerando as possibilidades de capacitação e apoio específico a projetos técnicos.
- ✓ As articulações institucionais precisam ser cultivadas e fomentadas permitindo que o SBG possa estar sempre informado a tempo sobre editais e possibilidades de intercâmbio e cooperação.
- ✓ As equipes do SBG, por sua vez, precisam estar sempre atentas e bem preparadas com capacidade de reagir e conseguir realizar as submissões e acolher a execução de conflitos internos.
- ✓ A Assuni é um local de ponte cuja missão é apoiar a que as iniciativas técnicas do SBG possam se beneficiar com incentivos de cooperação.
- ✓ A CPRM precisa seguir investindo em capacitação técnica, mas também em instrumentação. A compra do medidor de radônio e membranas extratoras de gases através das possibilidades de importação direta via CNPQ vai colocar o SBG em uma posição de destaque absoluto.
- ✓ É importante que o Programa de Isotopia aplicada a Hidrologia no âmbito da DHT do SBG siga recebendo recursos financeiros que garantam as missões de campo necessárias para as coletas de amostras para análises isotópicas.

VI – Agradecimentos

De forma geral agradeço o apoio recebido pelo SBG, principalmente da Diretoria Executiva e dos assessores da Presidencia. Apesar do custeio por parte da AIEA, a complementação do SBG nos poucos dias de extensão da missão fez toda a diferença. Agradeço o apoio financeiro concedido pela IAEA e a coordenadora do CRP *Wetland* Lucia Ortega pelo compromisso com o programa de isotopia do SBG.

VII – Anexos

Anexo I – Convites Oficiais da AIEA.



IAEA

Atoms for Peace and Development

وكالة دولية للطاقة الذرية
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Organismo Internacional de Energía Atómica

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Mr Roberto Kirchheim

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In reply please refer to: **EVT2102904**
Dial directly to extension: (+43 1) 2600-21741

2022-05-05

Dear Mr Kirchheim,

I have pleasure in inviting you to attend the **First Research Coordination Meeting on Isotopic Assessment of the Impacts of Climatic and Hydrological Changes on Wetland-Groundwater Ecosystem Interactions**, (hereinafter referred to as "event") which is being held by the International Atomic Energy Agency (IAEA) under the coordinated research project F33027 at its Headquarters in Vienna, Austria, from **13 to 16 June 2022**.

The purpose of the event is to present individual study areas, to develop work plans and outputs, and to review the analytical methods to be used during the project.

The event will be held in English.

I wish to extend to you, as an authorized co-worker from your institute, authorized by the IAEA as your representative No. 26193, a cordial invitation to participate in this event.

The IAEA will provide you with a lump sum equivalent to €2887 for the travel expenses to and from Vienna, Austria, and for living expenses, including incidentals, connected with the event. You will be fully responsible for making your own travel arrangements and for cancellation costs, if any. This amount has been calculated on the assumption that you will stay for the total duration of the event. Should this not be the case, you would be requested to reimburse the IAEA for appropriate difference.

It should be noted that compensation is not payable by the IAEA for any damage to or loss of personal property. The IAEA also does not provide health insurance coverage for participants in IAEA events. Arrangements for private insurance coverage on an individual basis should therefore be made. The IAEA will, however, provide insurance coverage for accidents and illnesses that clearly result from any work performed for the IAEA.

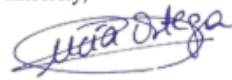
It is a condition of your acceptance that you refrain from disclosing any industrial secret or other confidential information made known to you by reason of your participation in this event, and that you exercise the utmost discretion with regard to all matters related to your participation as an expert.

In this regard, you are kindly requested to complete and sign the attached *Confidentiality Undertaking for Non-Staff Members* and to return it to me (Email: L.Ortega@iaea.org) in my capacity as the Scientific Secretary of the event prior to the start of the event. A breach of your obligation not to disclose confidential information without appropriate authorization, as provided for under the attached Confidentiality Undertaking, may result in the initiation of legal proceedings against you and that, for such purposes, the Director General may waive any immunity which may pertain to you.

The IAEA values the privacy of all event participants. For the purposes of collaboration and information sharing, the IAEA may share a list of event participants with other event attendees. This list may include the following personal data: name, country, institute or affiliation, address, telephone number and email address. Exclusion from this list is available upon request. Unless otherwise expressly agreed in writing by an individual event attendee, further dissemination of the list to third parties is not permitted.

I would be grateful to receive a reply at your earliest convenience whether you are in a position to accept this invitation.

Yours sincerely,



Lucia Ortega
Scientific Secretary
Division of Physical and Chemical Sciences
Department of Nuclear Sciences and Applications

Enclosure: *Confidentiality Undertaking for Non-Staff Members*

Anexo II – Publicação do Diário Oficial

COMPANHIA DE PESQUISA DE RECURSOS MINERAIS

DESPACHO

O Diretor-Presidente da Companhia de Pesquisa de Recursos Minerais - CPRM, no uso de suas atribuições legais, resolve autorizar o afastamento do país do Senhor ROBERTO EDUARDO KIRCHHEIM, Pesquisador em Geociências, Chefe da Assessoria de Assuntos Internacionais do Serviço Geológico do Brasil - SGB/CPRM, para viajar a Viena, Áustria, no período de 13/06/2022 a 24/06/2022, com o objetivo de participar de reuniões técnicas na Agência Internacional de Energia Atômica - AIEA, e Seminário Técnico, sobre uso de técnicas isotópicas aplicadas a Wetlands (Projeto do SGB com recursos aprovados pela AIEA).

ESTEVEZ PEDRO CONALGO





Tentative Agenda

First Research Coordination Meeting of CRP on

ISOTOPIC ASSESSMENT OF THE IMPACTS OF CLIMATIC AND HYDROLOGICAL CHANGES ON WETLAND-GROUNDWATER ECOSYSTEM INTERACTIONS

13-16 June 2022

IAEA Headquarters, Vienna, Austria
Vienna International Centre, M Building, Room M0E79

Organized by IAEA, Isotope Hydrology Section.

Project Officer: Ms. Lucía ORTEGA
L.Ortega@iaea.org T: (+43-1)2600-21741

Alternate Project Officer: Ms. Jodie MILLER

Team Assistant: Ms. Svetlana GUSEVA
S.Guseva@iaea.org T: (+43-1)2600-21738

All presentations are **30 minutes**, including 5-10 minutes for discussion.

Chairperson:
Mr. Prasanta Sanyal (India)

Rapporteurs:
Ms. María Emilia Zabala (Argentina)
Mr. Mohamed Fethi Ben Hamouda (Tunisia)
Ms. Josefina Hamutoko (Namibia)
Mr. Germain Esquivel-Hernández (Costa Rica)

Monday, 13 June 2022

Until 09:30	<i>Registration and gathering in Room M0E79. Please allow one hour to enter the VIC and to obtain your IAEA week pass. Breakfast is available in the VIC cafeteria (access participant's guide here).</i>
09:30 – 10:00	Introductory session Opening of the meeting Presentation of the participants IAEA Water Resource Programme and objective of CRP Election of Chairperson and Rapporteur Adoption of the meeting Agenda Ms. Jodie MILLER and Ms. Lucía ORTEGA , Isotope Hydrology Section, NAPC, IAEA.
10:00 – 17:00	CRP presentations
10:00 – 10:30	<i>Investigating the surface-groundwater connectivity in a volcanic lake system of Costa Rica</i> Mr. Germain ESQUIVEL-HERNANDEZ , Universidad Nacional de Costa Rica, COSTA RICA.
10:30 - 11:00	<i>Multi-isotope characterization of water resources for domestic supply in Ljubljana, Slovenia.</i> Ms. María Emilia ZABALA , Instituto de Hidrología de Llanuras "Dr. Eduardo Jorge Usunoff", ARGENTINA.
11:00 – 11:15	<i>Coffee break</i>
11:00 – 11:30	<i>Multitracing techniques applied to understanding water dynamics in the Pantaninho wetlands of the Tietê River Basin, Brazil.</i> Mr. Roberto KIRCHHEIM , Brazilian Geological Survey (SGB-CPRM), BRAZIL.
11:30 – 12:00	<i>What environmental isotopes can say about the alteration of wetland-groundwater relationships due to hydrological, land use and climate changes? The Doñana case of study, Spain.</i> Ms. Marisol MANZANO , Universidad Politécnica de Cartagena, SPAIN.

12:00 – 14:30	<p><i>Welcome lunch (hosted by IAEA)</i> <i>China-Restaurant Sichuan Wien (thesichuan.com) in Donau Park, 15 min walk from VIC, meeting at the VIC entrance at 12:05)</i></p>
14:30 – 15:00	<p><i>Application of isotope techniques for functional and qualitative assessment of groundwater-dependent ecosystems in the changing hydroclimate of the Mediterranean, case of alluvial, coastal and temporary wetlands of Corsica (France).</i></p> <p>Mr. Sebastien SANTONI, University of Corsica, FRANCE.</p>
15:00 – 15:30	<p><i>Assessment of water dynamics in Schinias-Marathon coastal wetland and its implications to the local ecosystem.</i></p> <p>Mr. Anastasios PAPADOPOULOS, Hellenic Centre for Marine Research, GREECE.</p>
15:30 – 15:45	<p><i>Coffee break</i></p>
15:45 – 16:15	<p><i>Geochemical and isotope characterisation of the groundwater of the wetland of Ghar El Meih Lagoon, Tunisia.</i></p> <p>Mr. Mohamed Fethi BEN HAMOUDA, National Centre for Nuclear Sciences and Technologies (CNSTN), TUNISIA.</p>
16:15 – 16:45	<p><i>Geochemical and isotopic assessment of climate change impacts on Reghaia's wetland-groundwater system (Eastern Mitidja, Algiers, Algeria).</i></p> <p>Ms. Dalale KHOUS, Algiers Nuclear Research Centre (Atomic Energy Commission), ALGERIA.</p>
16:45 – 17:00	<p>Brief summary of the day/additional questions.</p>

Tuesday, 14 June 2022

09:00 – 15:00	CRP presentations
09:00 – 09:30	<i>Investigations on the hydrological recharge processes of the Quaternary aquifer of Fitri in the Lake Chad basin.</i> Mr. Abdallah MAHAMAT NOUR , University of n'djamena, CHAD.
09:30 – 10:00	<i>Assessment of the hydrological processes and fluxes in wetland-groundwater ecosystems in semi-arid environments, an example from the Cuvelai-Etosa Basin, Namibia.</i> Ms. Josefina HAMUTOKO , University of Namibia, NAMIBIA.
10:00 – 10:30	<i>Isotope tracers to investigate changes in the water budget that supports wetland and estuarine systems in the Western Cape, South Africa.</i> Mr. Jared VAN ROOYEN , Stellenbosch University, SOUTH AFRICA.
10:30 – 10:50	<i>Coffee break</i>
10:50 – 11:20	<i>Application of water isotopes in disentangling the impact of macroscale climatic controls and microscale hydrological processes in groundwater-wetland ecosystems from the lower Ganga-Brahmaputra Basin (GBB), Indo-Bangladesh peninsula.</i> Mr. Prasanta SANYA , Indian Institute of Science Education and Research Kolkata, INDIA.
11:20 – 12:00	<i>IAEA Isotope Hydrology Laboratory: an overview</i> Mr. Takuya MATSUMOTO , Isotope Analyst, IAEA
12:00 – 13:30	<i>Lunch break</i>
13:30 – 14:30	<i>IAEA Isotope Hydrology Laboratory tour</i> <i>The group will be meeting outside the cafeteria at 13:30.</i>
14:30 – 16:30	<i>Group discussion: Sampling strategy to achieve CRP objectives (moderator: tbc)</i> <ul style="list-style-type: none">• Sampling guidelines and sampling kit• Sampling sites selection• Data requirements
16:30 – 17:00	Presentation of outputs and discussions

Wednesday, 15 June 2022

- 09:00 – 12:00 **Group discussion: analytical methods (moderator: tbc)**
- Methods and analytical services, comparison studies
 - Selection of suite of isotopes and other tracers to test
 - Elaborate on methods for future communication, team collaboration, data and model exchange
- 10:30 – 10:50 **Group photograph and Coffee break**
- 12:00 – 13:30 *Lunch break*
- 13:30 – 15:30 **Group discussion: Cooperation and knowledge sharing (moderator: tbc)**
- Knowledge and experience sharing, opportunities for collaboration.
 - Evaluate cooperation on analytical and sampling issues
 - Collaborative scientific and public writing
- 15:30 – 15:45 *Coffee break*
- 15:45 – 17:00 **RCM Report writing**
- Establish detailed CRP work plan and objectives
- Agree on outputs
 - Propose dates and venues for next RCM

Thursday, 16 June 2022

- 09:00 – 12:00 **Finalizing CRP work plan and draft meeting report.**
- Preparation of final PPT presentation.
- 12:00 – 12:30 **Presentation of CRP work plan for the group and Isotope Hydrology Section.**
- 12:30 – 13:30 **Closing remarks and end of the meeting.**

Anexo IV – Lista de Participantes

<p style="text-align: center;">F33027-CR-1 First Research Coordination Meeting on Isotopic Assessment of the Impacts of Climatic and Hydrological Changes on Wetland–Groundwater Ecosystem Interactions 13 to 16 June 2022 List of Participants (as of 2022-05-07)</p>		
S. No.	Authority	Personal Details
1	Algeria	Ms Dalale KHOUS Algiers Nuclear Reseach Centre/ COMENA 02 Bd Frantz Fanon, 399 Alger-RP 16000 ALGIERS ALGERIA Tel: Email: dkhous@cma.dz
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Anexo V – Country Summary

Country

Project title: *Multitracing Techniques assesment on understanding the water dynamics in the Wetlands ("Pantãozinho") of the Tietê River Basin, Brazil*

CSI: *Roberto Kirchheim/Maria Antonieta Mourão*

Affiliation: *Geological Survey of Brazil*

Email: *Roberto.kirchheim@cprm.gov.br*

1. INTRODUCTION

This proposal aims to understand the local dynamics of GAS (Guarani Aquifer System) recharge and discharge and its specific relationship with two wetlands associated with the Tietê River Basin in the State of São Paulo. Both water bodies are located in outcrop regions of the GAS's main aquifer units. Traditionally seen as potential recharge areas, as new studies are being developed, these areas show important discharge behaviors and a relationship of maintenance of aquatic ecosystems that had been largely underestimated until then. Assessing the role of GAS groundwater in the formation and maintenance of these two contiguous wetland systems and thus highlighting the role of ecosystem services performed by GAS groundwater constitute the goals of the proposal. Therefore, the proposal involves the combination and application of multitracer techniques involving stable isotopes, radon techniques, nitrogen isotopes, noble gases, in addition to dating techniques using ^3H , ^3H - ^3He and ^4He . The GAS in Brazil and specifically in the State of São Paulo has been extensively studied using isotopic techniques, but always on a regional scale. In this sense, the present study represents a challenge and a concrete possibility to test these methodologies and develop local national and continental capacities.

2. STUDY AREA(s)

The present work sharpens the focus on an area of wetlands seated on outcrop areas of the GAS in the State of São Paulo. The considered wetlands (Figure 1) are part of an environmental conservation area in the State of São Paulo with clear policies for the conservation of the remnants of natural ecosystems and to expand environmental services and ecological conditions for the maintenance of wildlife. Analogous to the study undertaken by Lucia et al, 2021 in the Wetland of Esteros del Ibera in Argentina, the aim here is to investigate the origins, dynamics and interfaces with the waters of the GAS through the use of multi-tracer techniques, preceded more detailed assessments from the point of view of the geological and hydrological framework of the area. It is an emblematic target from the conceptual point of view of the GAS whose understanding will certainly bring not only a new view of the specific dynamics valid for the site itself, but will also constitute a reference for new interpretations in all of the GAS's outcrop areas. Wetlands and aquifers cannot be interpreted as watertight and independent entities. There is a connectivity between them, which is precisely essential for maintaining the quality and quantity of water in both. The dynamics of this connectivity need to be understood, as a basis for protecting these wetlands, as well as for the sustainability of groundwater systems. A quantitative assessment of the balance of inputs and outputs is necessary, that is, the

hydrological processes at work, including water origin, paths taken by the water, residence times, influence of evapotranspiration. They are essential information for decision makers to be able to assess current and future impacts related to anthropic interventions and/or due to climate change. The combined use of stable environmental (rain, surface bodies and groundwater) and radioactive isotopes with traditional hydrogeological methodologies (remote sensing, geological mapping, geophysics, hydraulic tests and hydrochemical campaigns) provides answers to the essential questions raised and demanded here.



Figure 1. Wetlands “Pantanimhos” in Southeast Brazil.

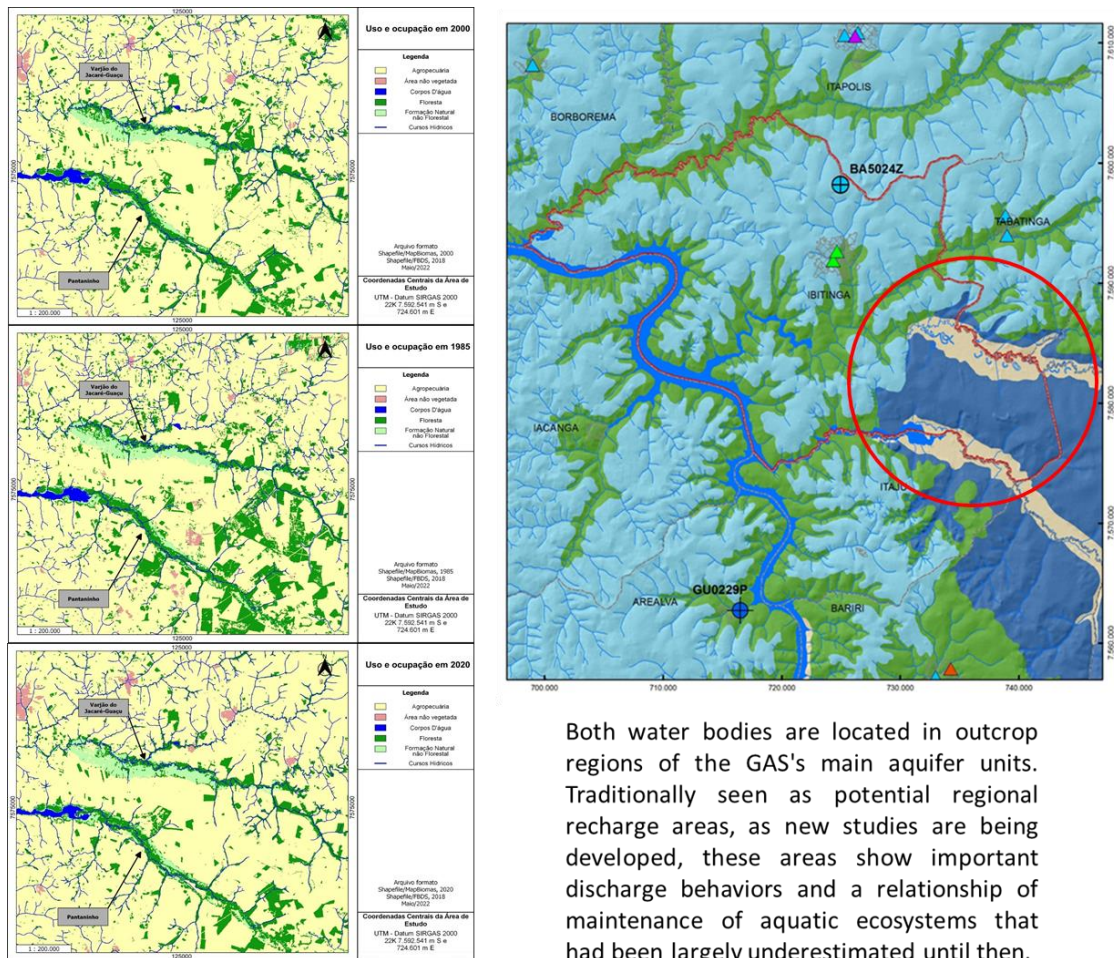
3. STATE OF KNOWLEDGE

Recognized as one the most important worldwide transboundary regional aquifers, the GAS has been the target of extensive research efforts. The aquifer potential to supply large amounts of water for domestic, agriculture, and industrial use is well known and served as a key motivation factor to understand its circulation model. However, despite the huge volumes of groundwater stored in GAS, its recharge rates are considered low. Overall demands are rising significantly, mainly at confined areas associated with agribusiness and recreation thermal plants, and large drawdowns and pressure losses have been already registered. It is a similar scenario experienced by other regional continental aquifers around the world. Isotope approaches started early in the 1970s, thanks to international cooperation, coinciding with the advent of isotopic techniques in Brazil. The application of isotopes in the enhancement of the GAS hydrogeological knowledge covered different phases. Early assessments dealing with stable isotopes determination focused on very restricted areas near recharge outcropping zones. Later, studies evolved to address preliminary questions regarding GAS regional flow dynamics from

recharge to confined areas. Recharge areas were first recognized through piezometric head measurements followed by the development of regional flow nets. Early isotope data revealed different palaeoclimatic recharge conditions. Regional flow occurred from the northern recharge areas towards the south along the main basin axis, coinciding with the Paraná River. Sampling campaigns started to reach confined areas, far from those studied during the first phases (as GAS confined areas begun to be tapped by deep wells in other Brazilian states) and recharge areas in the west and southern aquifer borders. Hydrogeochemistry tools were used to interpret isotope data and reduce uncertainties on flow directions and age estimations through ^{14}C method, allowing the proposal of distinctive conceptual models for the GAS. Initial age estimates allowed the reconnaissance of large flow lines from well-known recharge areas through a relatively homogeneous aquifer body, divided into a northern block and a southern block, partially separated by the Ponta Grossa Arch. Most of the ^{14}C age estimates for the GAS confined areas proved to be inappropriate, however, because they were near or exceeded the method limits. New tracers such as U isotopes and He were then used, along with some isolated trials with ^{36}Cl . After an extensive hydrochemistry assessment along flow lines representative of the whole GAS system and a better understanding of the role played by the basin tectonic structures, a new conceptual model based on four compartments was developed. The need to check for GAS representative samples as further aquifer development takes place is important and shall not be forgotten. Present ongoing research is aimed at finding a convergence between hydraulic modeling, GAS hydrochemistry evolution, and groundwater age estimates based on multitracer approaches. Samples from deep GAS confined areas were collected for noble gases allowing the application of combined ^{81}Kr and ^4He age proxies. Complementary research efforts are being made to assess different flow lines covering the whole GAS in order to evaluate He influxes heterogeneities and the ^{81}Kr - ^4He model validity. As soon as the new modeled age results and noble gases recharge palaeotemperatures are delivered, more enhanced and complete conceptual models are going to be necessary to cope with the new findings. Isotope assessments proved to be helpful in building conceptual flow models, mainly defining aquifer size and compartmentation; direction and magnitudes of flow lines can be tested and compared with aquifer data obtained from hydraulic approaches; aquifer outcropping areas in terms of recharge and/or discharge behavior may better defined; Isotope information, once interpreted in an integrated way, is considered to be crucial for storage estimates, water balance, estimation of renewal rates, and therefore better define sustainable water management strategies.

Groundwater age dating using ^4He and long-lived radionuclides offered additional constraints for the conceptual groundwater flow model. As a result, lower groundwater recharge rates for the GAS have been estimated to be at least one order of magnitude lower than previously considered.

This understanding of the regional dynamics of the GAS needs to be complemented by studies of a more detailed scale in strategic areas, starting with an understanding of the recharge and discharge functions of some GAS outcrop areas. The study by Santarosa et al. (2021) estimated the spatial and temporal variability of recharges that take place in the GAS outcropping range of the State of São Paulo. This is a study that brings conceptual advances, but even so, given its regional character, it fails to provide answers about the conceptual model through which recharges and/or discharges are processed.



Both water bodies are located in outcrop regions of the GAS's main aquifer units. Traditionally seen as potential regional recharge areas, as new studies are being developed, these areas show important discharge behaviors and a relationship of maintenance of aquatic ecosystems that had been largely underestimated until then.

Figure 2. Land use patterns change and geological framework of the area.

4. RESEARCH OBJECTIVES

4.1 Main objective

This study will seek to understand the functional dynamics of wetlands and their relationship with groundwater (in particular, the SAG waters), defining specific recharge/discharge conceptual models.

4.2 Specific objectives

This understanding is considered essential to assess impacts due to changing patterns of water and land use and/or future climate change. In this sense, we will seek to understand the ecosystem role of wetlands and groundwater (protection against droughts and floods, maintenance of flora and fauna, amortization and fixation of agrochemical contaminants). From a specific point of view, the study will test, promote and provide guidance on the applicability and efficiency of a series of isotopic techniques for this type of scenario, in particular, for the many similar areas within the scope of GAS in the South American continent and other similar aquifers. From the determination of sources, interactions and flow paths of groundwater systems that support the main types of wetlands, it will be possible to develop guidelines for best practices in the integration of environmental isotopes and other indicators in the evaluation of hydrological processes for the efficient management of water resources in groundwater systems and dependent wetlands.

5. METHODOLOGY

The methodology consists of the combination of very specific components: (i) Characterization of the geological framework supported by geophysical transects; (ii) Hydrological and hydrogeological diagnoses; (iii) Field campaigns to collect hydrochemical and isotopic samples based on the multi-tracer approach; (iv) Radon transects and use of field mass spectrometer for noble gases; (v) Drone assessments and remote sensing (v) Discussion of results and development of final reports and publications.



Figure 3. Examples of the Instruments to be used on the field campaigns (Portable Field Spectrometer for Gases, Drone for DEM and Land Use Assessment, Radon Equipment built on a boat).

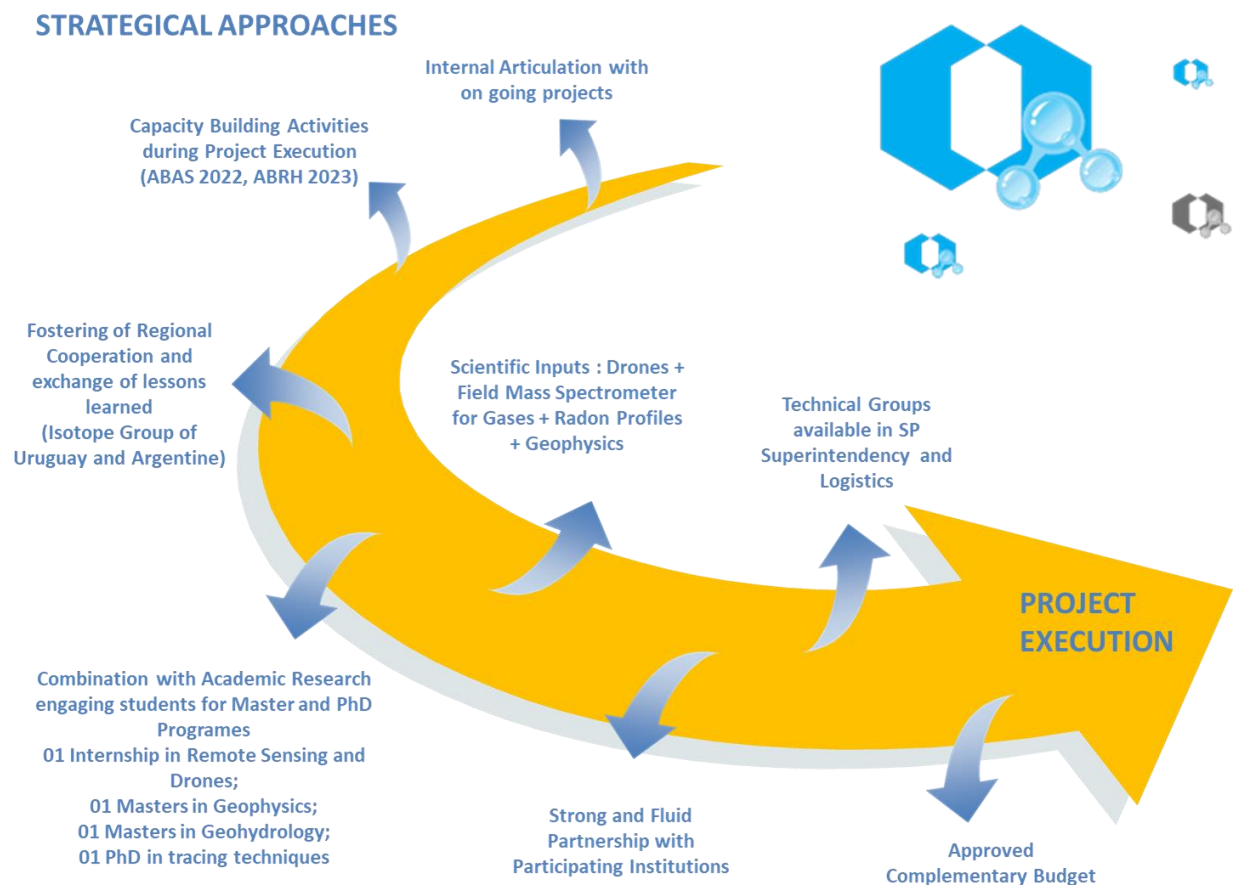


Figure 4. Strategical approaches of the submitted project

6. WORK PLAN

The Work Plan proposed for this Project consists of the following phases:

- Activity 1: Recognition and assessment of the geological and hydrological framework;
- Activity 2: Generation of cartographic base maps and Remote Sensing approaches;
- Activity 3: Geophysical Assessment
- Activity 4: Selection of stable isotope, 3H, 3H-3He and Noble Gases sampling stations (rain, superficial water and groundwater) and Radon transects;
- Activity 5: (Wet season) Field Campaigns for Isotopes and hydrochemistry;
- Activity 6: Field Campaign for Radon Transects;
- Activity 7: Analytical task force and Evaluation of preliminary results;
- Activity 8: (Dry season) Field Campaign for Isotopes and hydrochemistry;
- Activity 9: Field Campaign for Radon Transects;
- Activity 10: Analytical task force and Evaluation of total results;
- Activity 11: Systematization of data and development of report;
- Activity 12: Paper development and workshops for capacity building and institutional strengthening;

Main Work Programme (Quarters/year)

Activit y	02/2 2	03/2 2	04/2 2	01/2 3	02/2 3	03/2 3	04/2 3	01/2 4	02/2 4	03/2 4	04/2 4	01/2 5	02/2 5
A1													
A2													
A3													
A4													
A5													
A6													
A7													
A8													
A9													
A10													
A11													
A12													

7. EXPECTED OUTPUTS

- Output 1: Base Map and GIS Data Set;
- Output 2: 160 samples analyzed for stable isotopes, 20 for 3H and 3H-3He and Noble Gases (considering the 04 campaigns);
- Output 3: 24 rain samples for stable isotopes and ³H;
- Output 4: 160 samples analyses for hidrogeochemistry;
- Output 5: 04 geoelectric profiles comprising 4km with 3D geological conceptual model;
- Output 6: 8 Transects for Radon (considering the two campaigns) comprising 4km of survey;
- Output 7: Evaluation of the data set and development of the final report

- Output 8: Conceptual model for the wetland-aquifer connection
- Output 9: Capacity Building seminars with intervening institutions
- Output 10: Master and PhD thesis
- Output 11: Development of papers for publishing in prestigious journals

Annex VI – Country Template

Multitracing Techniques Assessment on Understanding the Water Dynamics in the Wetlands ("Pantaninho") of the Tietê River Basin, Brazil



Brazilian Words for Wetland: Banhados, Áreas Úmidas, Pântanos, Zonas Alagadiças



Both wetlands are located in outcrop region of the Guarani Aquifer System (GAS). Traditionally seen as potential regional recharge areas, as new studies are being developed, these areas show important discharge behavior and important functions in maintenance of aquatic ecosystems that had been largely underestimated until then.



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