



World Groundwater Congress
IAH2024 DAVOS
Switzerland



**GEOLOGICAL
SURVEY
OF BRAZIL**

STATE OF THE ART OF THE INTEGRATED NETWORK FOR MONITORING GROUNDWATER IN BRAZIL.

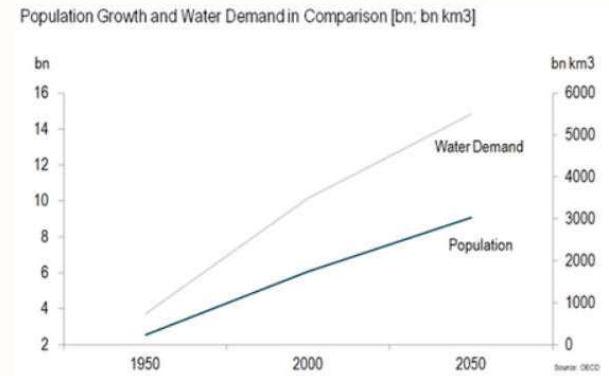
*Daniele Genaro
Roberto Kirchheim
Idembergue Barroso Macedo de Moura
Andrea Segura Franzini
Katarina Rempel*

13 of September 2024

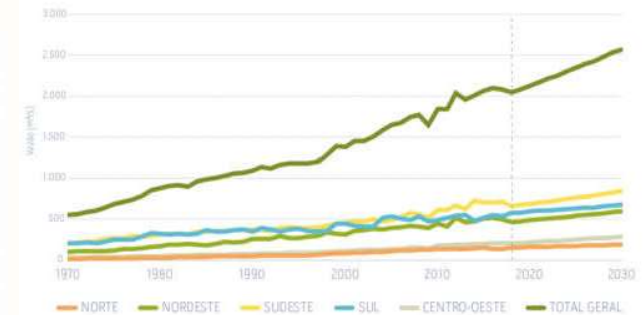


Motivation

- ✓ Increase of the populations and water demand;
- ✓ Variability of available water supplies/Climate changed; and
- ✓ Assurance of the capacity for the energy transition.

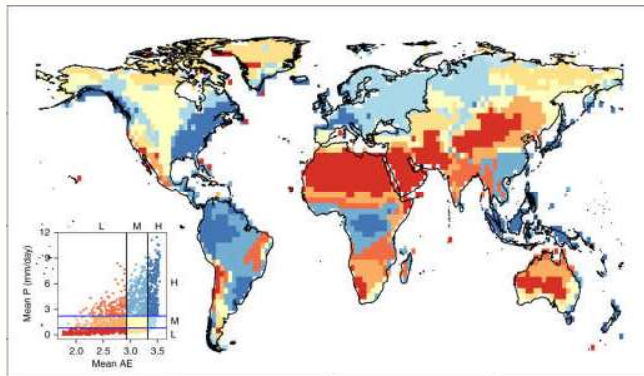
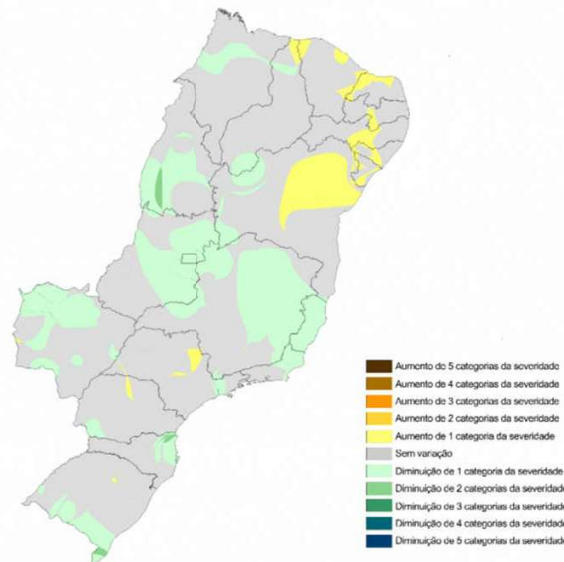


EVOLUÇÃO DA RETIRADA DE ÁGUA NO BRASIL
por Região Geográfica (1970-2030)



From: Conjuntura ANA 2021

Monitor de Secas - Alterações Mensais
Fevereiro21/Janeiro21

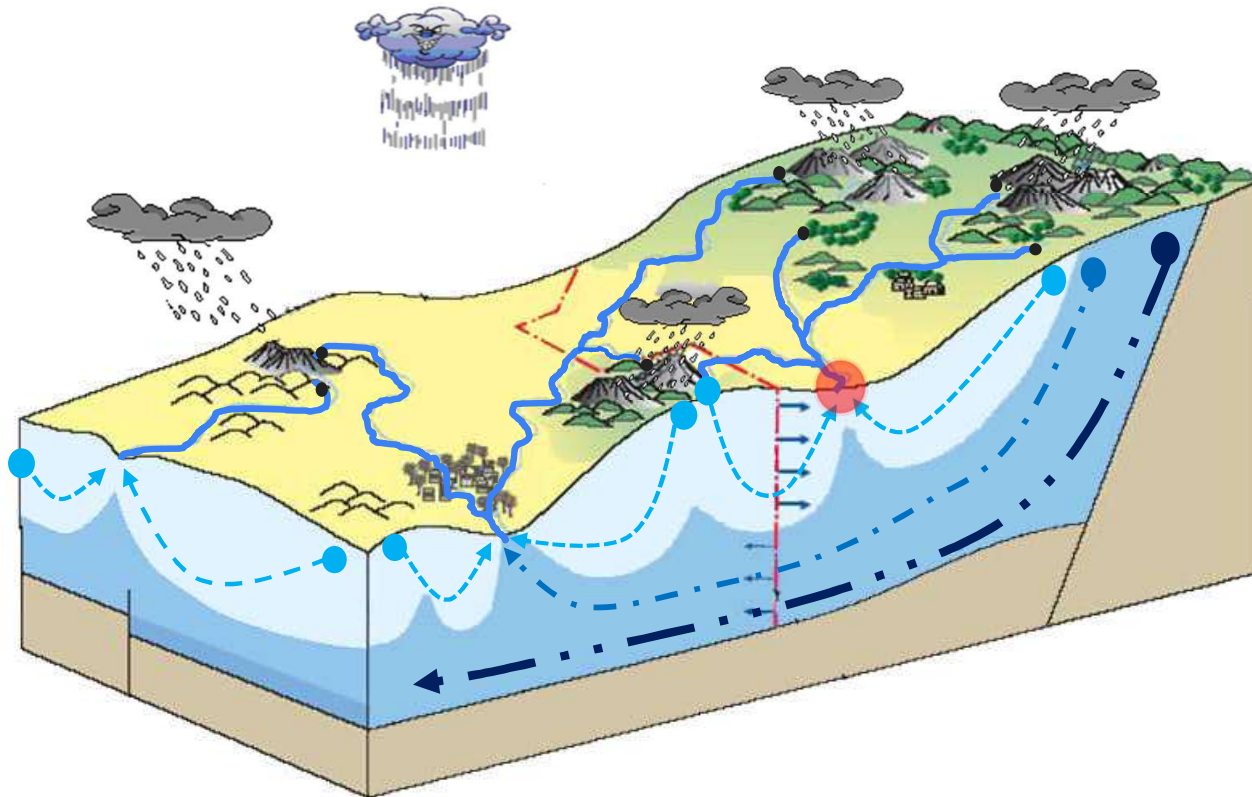


From: [Climate change will affect global water availability through compounding changes in seasonal precipitation and evaporation](#)



Motivation

Hydrological cycle



(Puri, 2002; ANA, 2010)





Integrated Groundwater Monitoring Network - RIMAS

GOALS

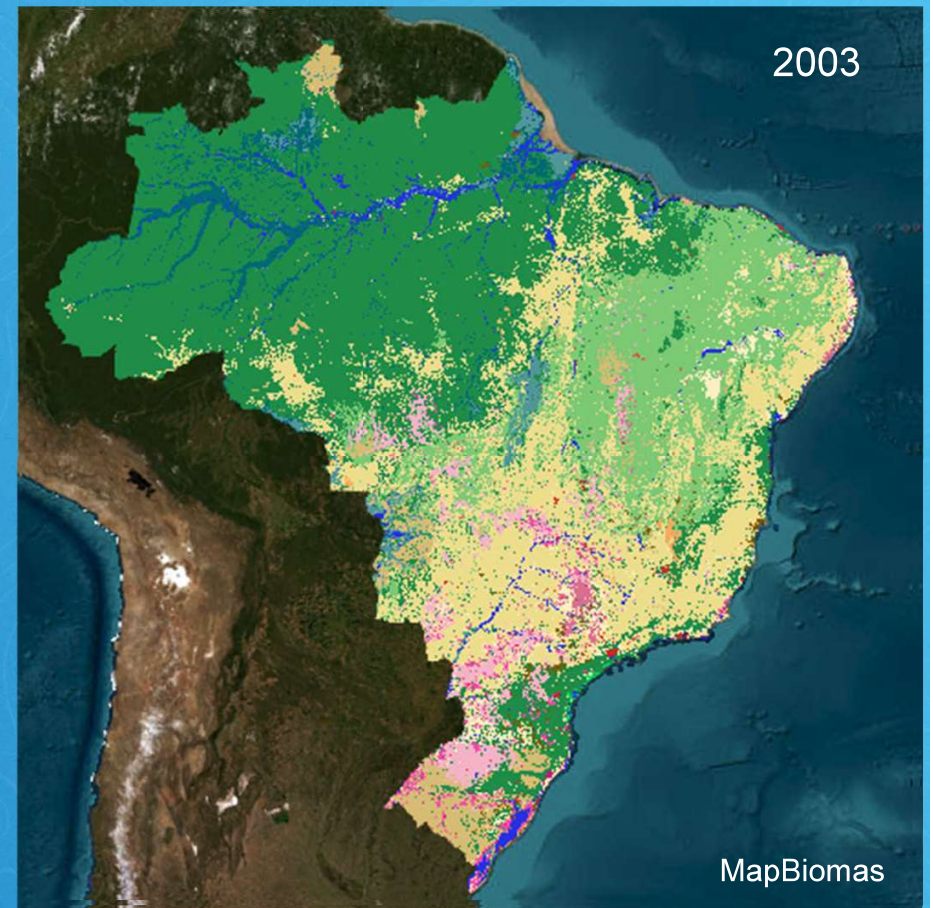


- **Promote an evaluation of the quantitative condition of bodies of groundwater, including the assessment of the availability of the groundwater resource;**
- **Establish assessments of long-term trends, both as a result of changes in natural conditions and derived from anthropogenic activities;**
- **Define the qualitative state of water bodies (natural bottom);**
- **Evaluate the reversal of trends in qualitative and/or quantitative conditions after the implementation of mitigating measures;**
- **Establish the degree of interaction between groundwater and water superficial.**



Integrated Groundwater Monitoring Network - RIMAS CHALLENGES

- ✓ How to deploy a groundwater monitoring network in a country of continental size and marked by large socioeconomic differences and high variability of hydrogeological environments?
- ✓ How to optimize human, financial and technical resources into design of the monitoring network in order to improve the hydrogeological knowledge and to promote the integrated water resources management?





Resumen Definitions



- **NATIONAL NETWORK;**
- **QUANTITATIVE AND QUALITATIVE GROUNDWATER;**
- **INTEGRATED → RAIN GAUGE STATIONS;**
- **WELLS MOSTLY CONSTRUCTED AND DEDICATED;**
- **SEDIMENTARY BASINS AND/OR WATER DEMANDS;**
- **AUTOMATIC LEVELS (DATALOGGERS/TELEMETRY);**
- **RECHARGE AREAS;**
- **GOVERNMENT FUNDING; and**
- **PUBLIC DATAS.**





Natural Conditions

Before



Foto 01 - Poço de Monitoramento no Município de Almeirim/PA

After

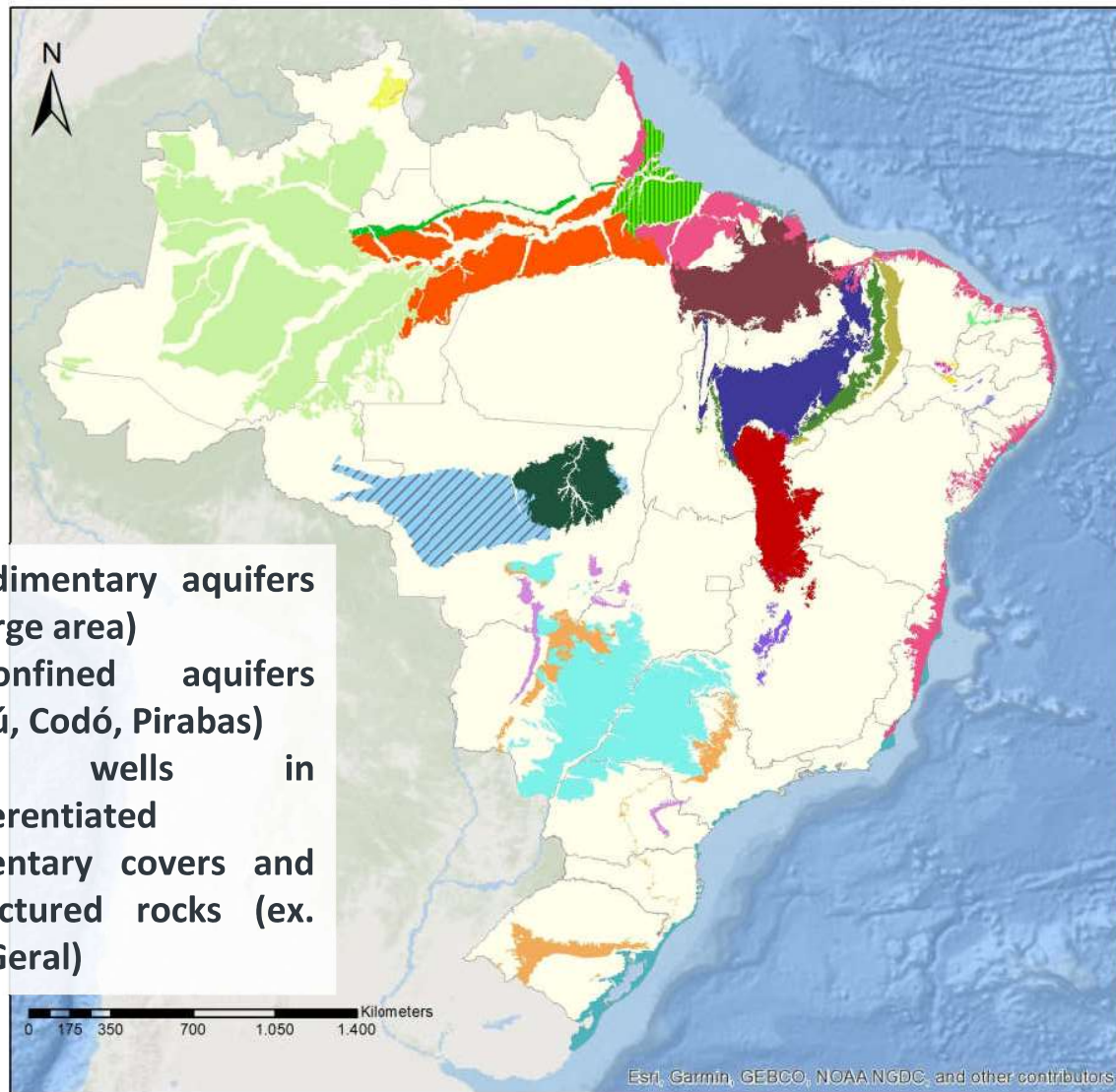


Foto 02 - Poço de Monitoramento no Cemitério Parque de Mênasis, Bairro Tarumã



Actual Scenario	
31	Aquifers
22	States
76	PCDs Installed near the monitoring wells

24 sedimentary aquifers (recharge area)
 3 confined aquifers (Grajaú, Codó, Pirabas)
 Some wells in undifferentiated sedimentary covers and in fractured rocks (ex. Serra Geral)



Adopted definitions



- Groundwater level– EVERY HOUR
- Physical-Chemical Parameters (Water quality indicators): Nitrate, Nitrite, pH, Electrical Conductivity, Eh, Temperature, color – In situ sampling and determination – BIANNUAL
- Complete Physical-Chemical Analysis (organic and inorganic compounds) – FIVE-YEAR (it may change in case of significant variation)
- Rainfall, Relative Humidity and Barometric Pressure : EVERY HOUR
- Isotópicos – GNIP's and well's - DISTINCT



Three to four annual visits to extract data stored in equipment dataloggers, manual measurements of water levels and maintenance of stations

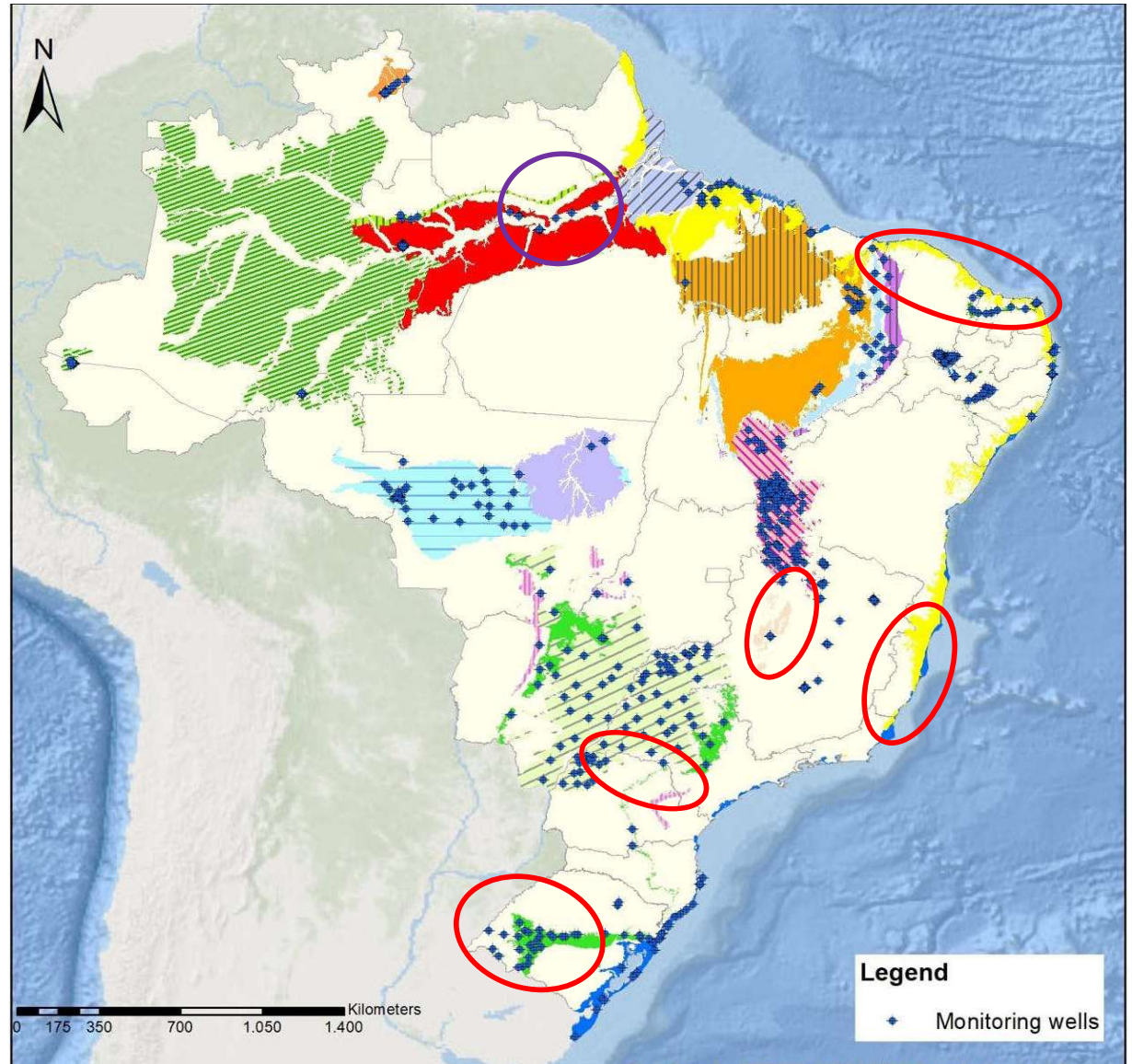
Nowadays - starting a telemetry process in the wells



Integrated Groundwater Monitoring Network - RIMAS

RIMAS
Rede Integrada de Monitoramento
das Águas Subterrâneas

477 points of
monitoring





Monitoring Qualitative



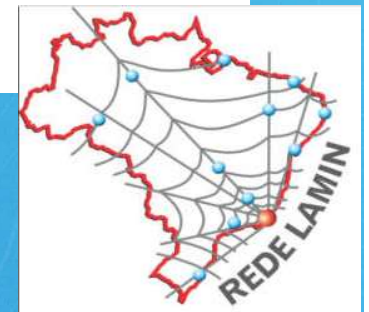
ção de CN,

por plasma
Cd, Pb, Cu, C
Ti.
to, nitrito,



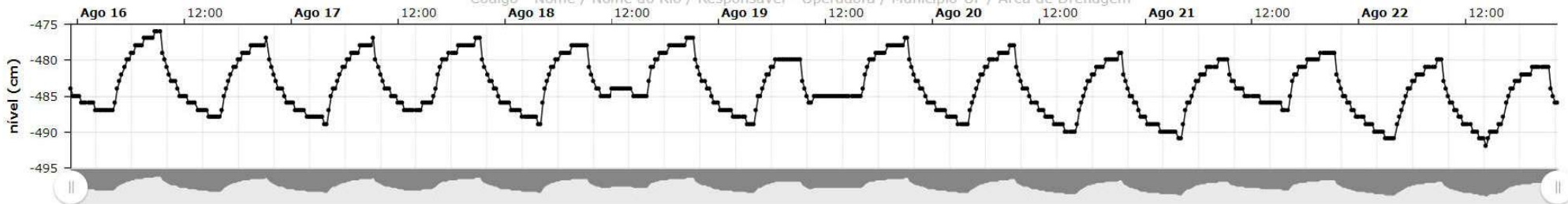
- Por AAGVF (Absorção Atômica com Ge
- Por titulometria: alcalinidade

Agrotóxicos e Orgânicos Voláteis– LAMIN



1643049 - PZ_FAZENDA REATA // ANA / CPRM / CAPITÃO ENÉAS / MINAS GERAIS / 0km²

*Código - Nome / Nome do Rio / Responsável - Operadora / Município-UF / Área de Drenagem



Sistema HIDRO - Telemetria

Mapa Estações Visualizar Dados Relatórios Gerenciar Fale Conosco

Caro Visitante
Faça o seu Login
Agência Nacional de Águas

Cadastro das Estações Telemétricas

Filtrar por: Listas Pesquisa Setor Elétrico

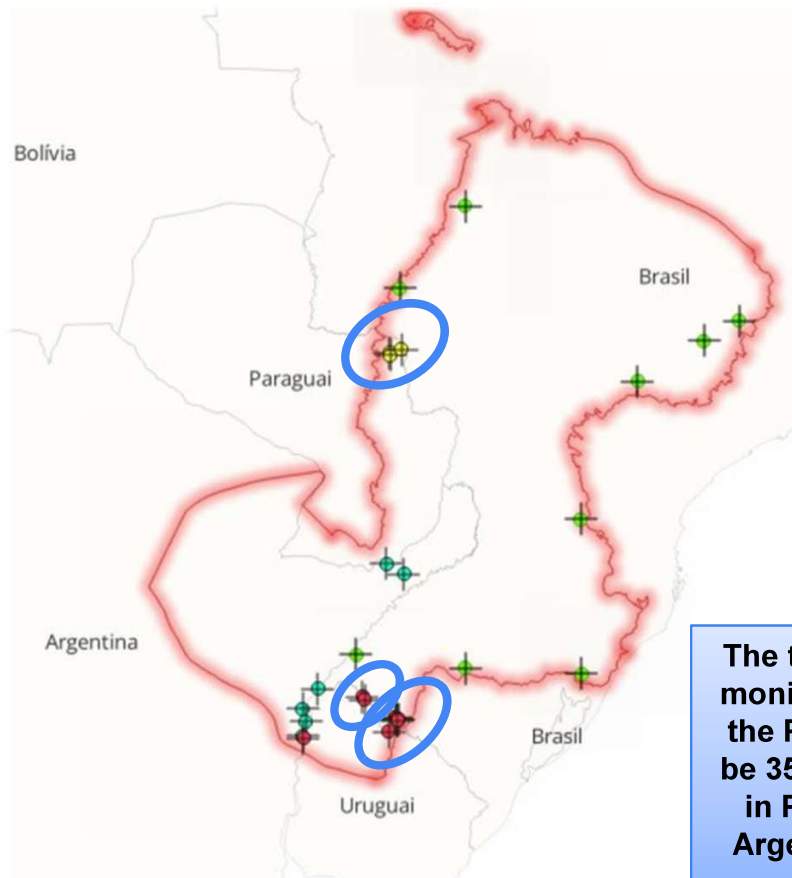
Estados: 0 - <Todos> MG	Origens: 0 - <Todos> 5 - RHN	Bacias: 0 - <Todos> 4 - RIO SÃO FRANCISCO	Sub-bacias: 0 - <Todos> 44 - RIOS SÃO FRANCISCO,VERDE	Estações: 5 - 01543028 - PZ_FAZ SANTA HELENA 5 - 01543029 - PZ_LINHA II 5 - 01543030 - PZ_PROJ JAÍBA 5 - 01543031 - PZ_FAZENDA MATA VELHA 5 - 01543032 - PZ_BARREIRO VERMELHO 5 - 01643045 - PZ_BOM JARDIM 5 - 01643046 - PZ_BARRA DO RIO VERDE 5 - 01643047 - PZ_PELG 5 - 01643048 - PZ_ETE VIEIRA 5 - 01643049 - PZ_FAZENDA REATA	Pesquisar Por: <input checked="" type="radio"/> Estação <input type="radio"/> Município <input type="radio"/> Rio <input type="text" value="pz_"/>	Status da Estação <input checked="" type="checkbox"/> Ativo <input type="checkbox"/> Manutenção <input type="checkbox"/> Desativada
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Total de registros encontrados: 10.



5 usuário(s) online

PEA – STRATEGIC ACTION PLAN – GUARANI AQUIFER

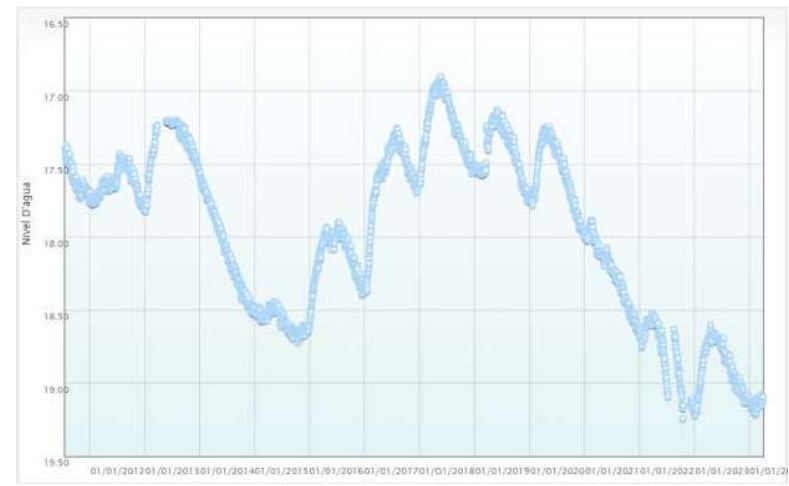
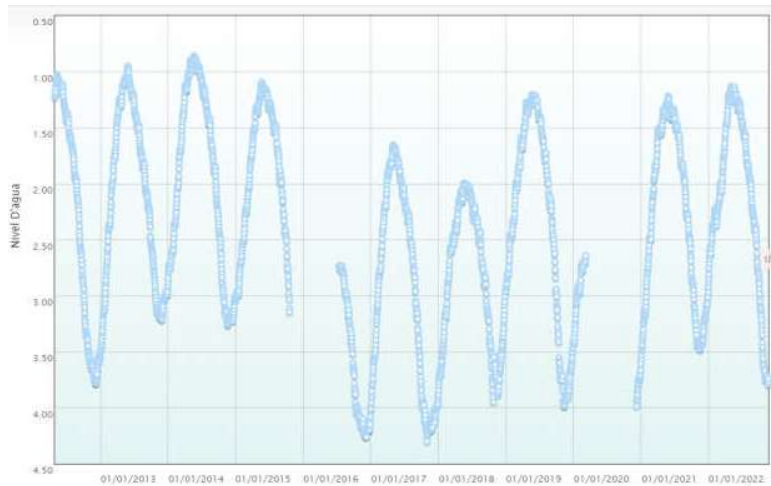
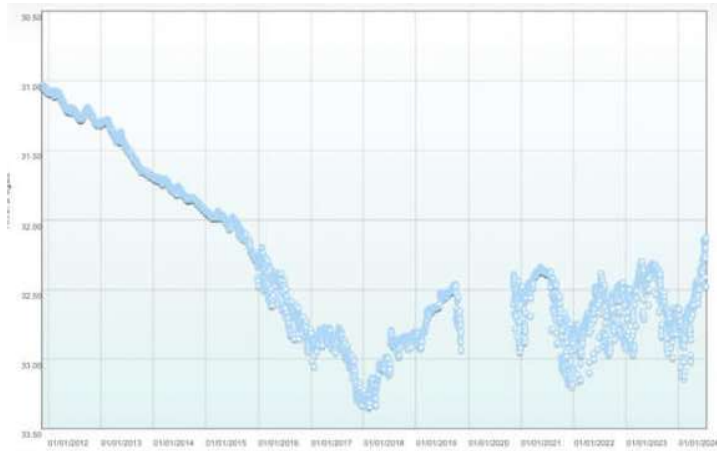


The total number of monitoring wells for the Pilot Phase will be 35 (15 in Brazil, 8 in Paraguay, 6 in Argentina and 6 in Uruguay).



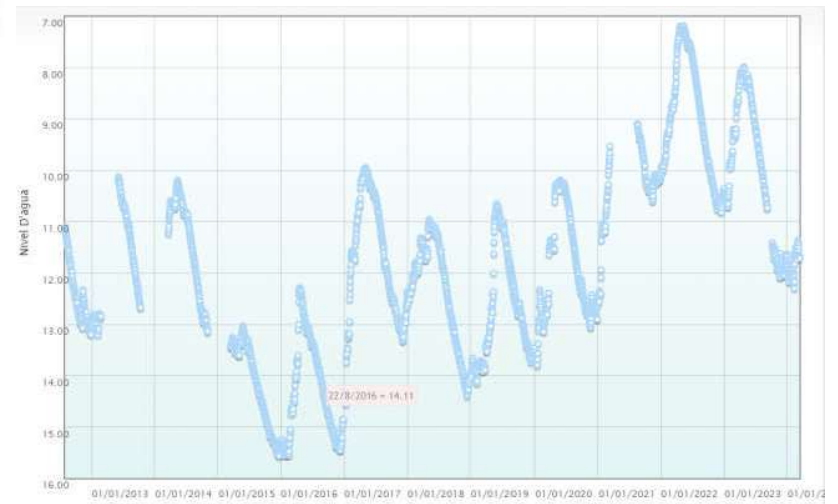
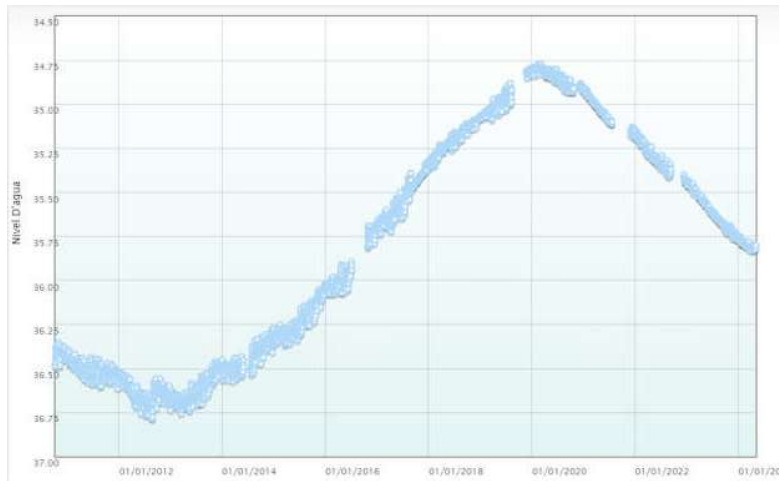
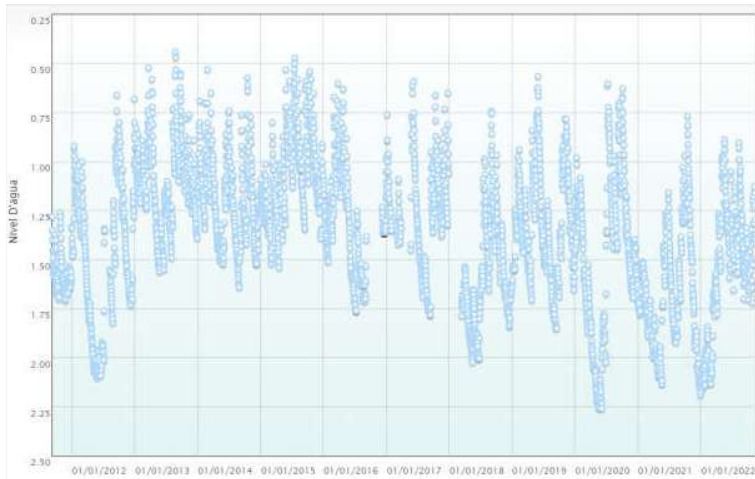


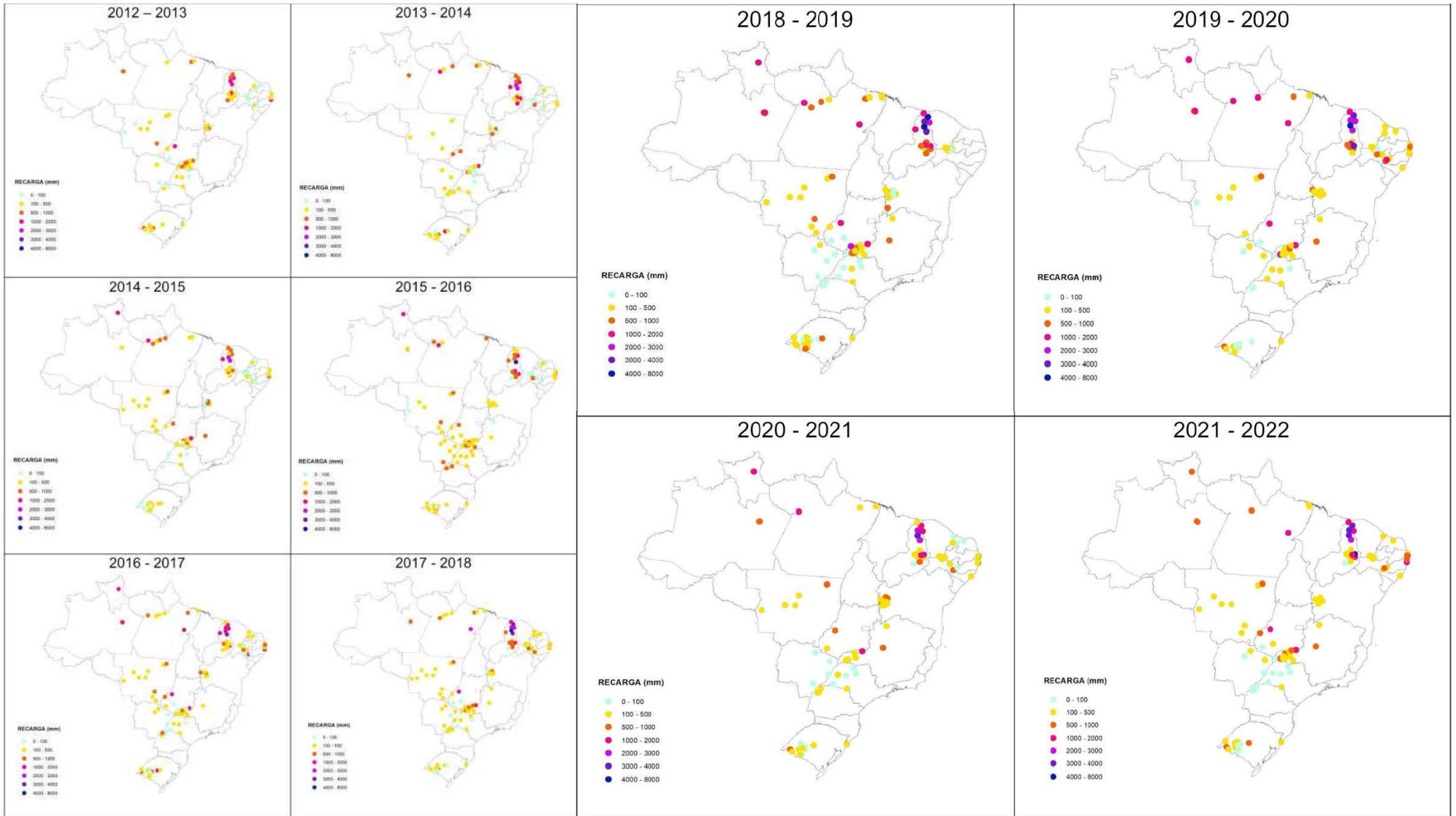
Some examples of time series





Some examples of time series







Método PIRFCT (*Predefined Impulse Response Function*) através do software *Menyanthes*

by *Guilherme Santos*

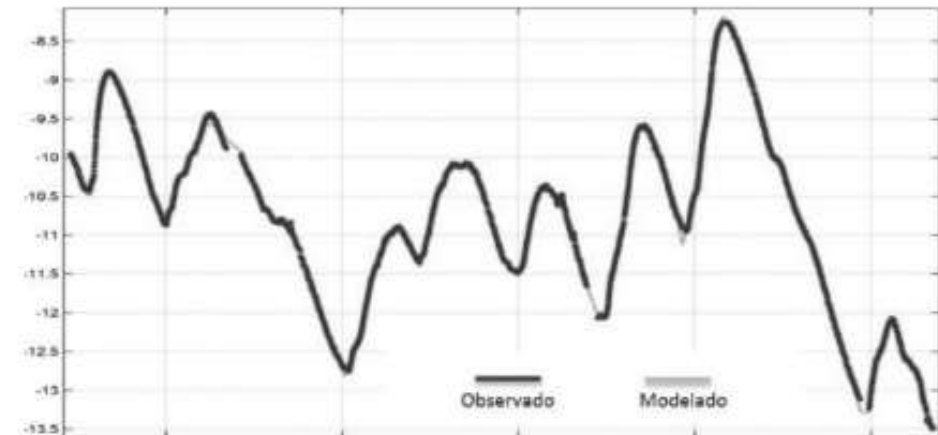


Figura 2. Modelo de comportamiento del nivel de Dic/10 a Sep/20.

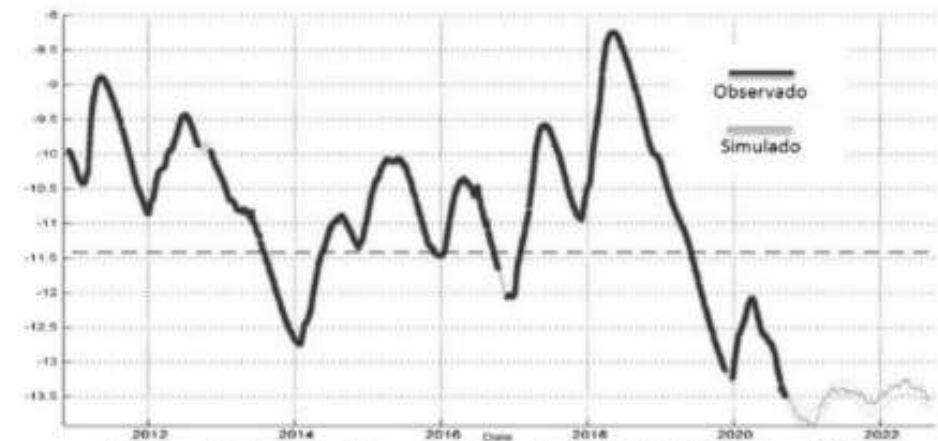
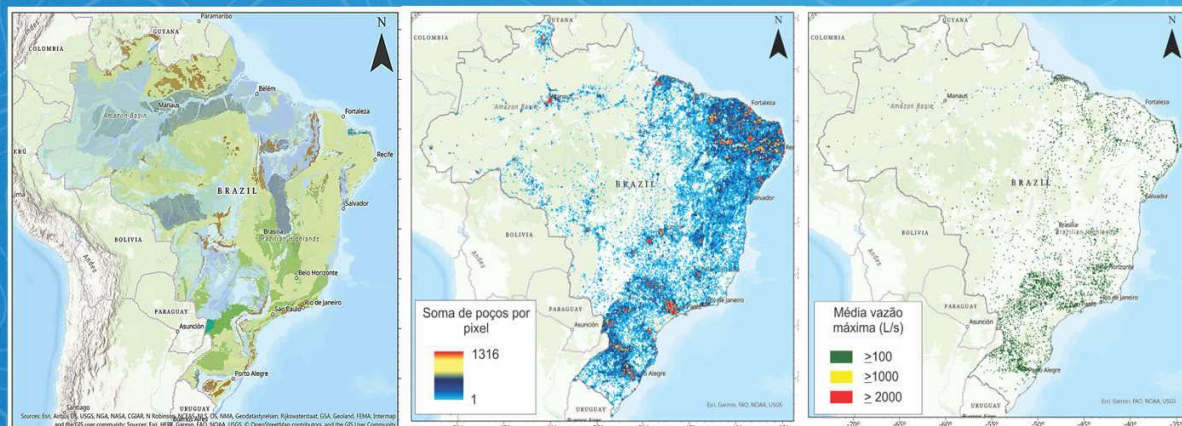
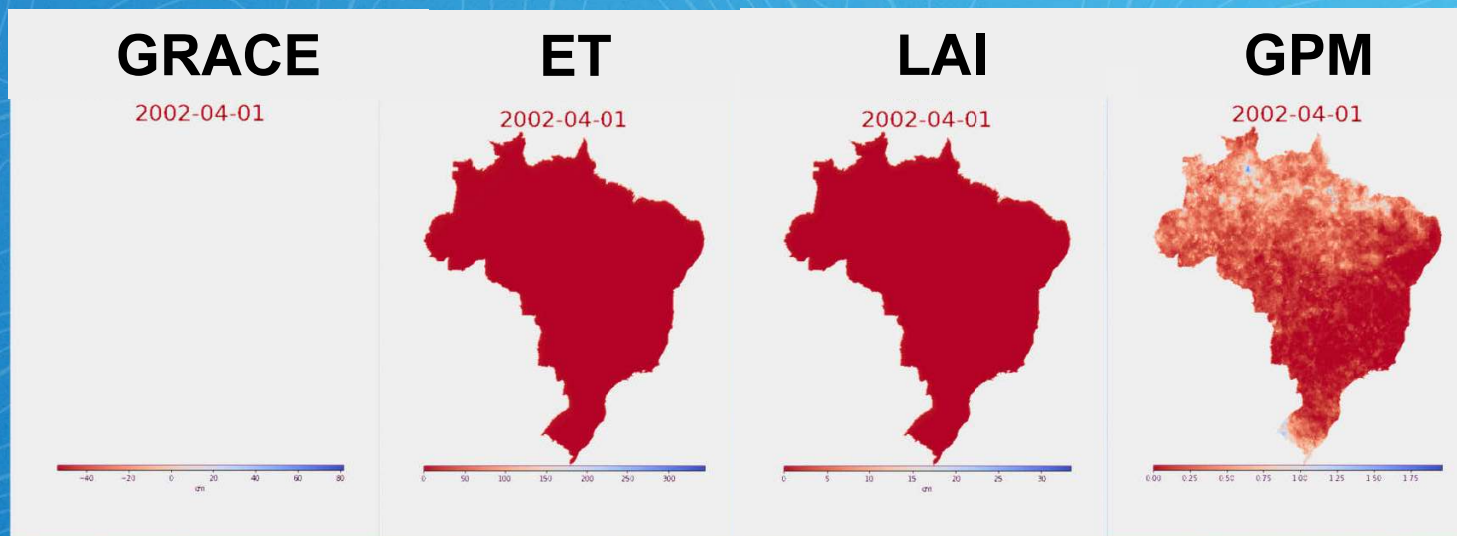


Figura 3. Simulación para el periodo del Set/20 a Ago/22.

The model built to simulate storage in Brazil assimilates data (by Clyvikh Renna Camacho):



Model adjustment for Brazil.

Root mean square error **RMSE = 1.32cm**

Mean error **MAE = 0.78cm**

Nash-Sutcliffe efficiency **NSE = 0.90**

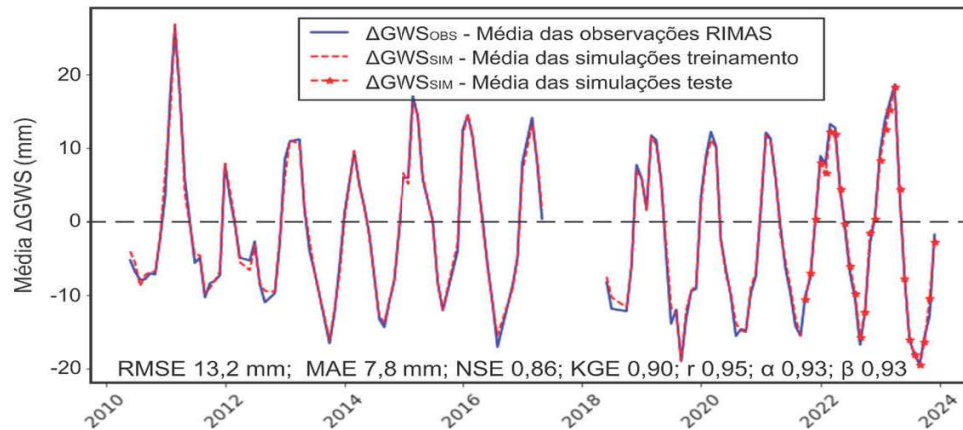
R2 = 0.90

King-Gupta efficiency **KGE = 0.90**

Measure of phase between simulations and observations **KGE_r = 0.95**

Ratio between simulated and observed averages **KGE_{alpha} = 0.93**

Ratio between simulated and observed standard deviation **KGE_{beta} = 0.93**



Perfil Construtivo

Gerais | Construtivos | Geológicos | Monitoramento Nível D'água | **Monitoramento Hidroquímico** | Teste Bombeamento | Relatórios e Multimídias

Análises Químicas:

Arvores: 0219/PD/PV01
 Data da Coleta: 04/06/2019
 Condutividade Elétrica (µS/cm): 38.80
 Qualidade da Água (PT/CO):
 Sabor da Água:
 Qualidade da Água (Olor):
 Temperatura (°C):
 Turbidez (NTU): 0,44
 Sólidos Suspensos (mg/l):
 Sólidos Sedimentáveis (mg/l):
 Aspecto Natural:
 pH: 5,53

Resultados Analíticos da Última Coleta:

Parâmetro:	Concentração:	Unidade:
Calcio (Ca)	1,98	mg/L (ppm)
Cloro (Cl)	2,279	mg/L (ppm)
Cromo (Cr)	0,019	mg/L (ppm)
Dureza total	8,56	mg/L (ppm)
Fluoretos (F)	0,015	mg/L (ppm)
Ferro total (Fe)	0,096	mg/L (ppm)
Potássio (K)	3,82	mg/L (ppm)
Magnésio (Mg)	0,96	mg/L (ppm)
Manganês (Mn)	0,014	mg/L (ppm)
Sódio (Na)	1,56	mg/L (ppm)
Niquel (Ni)	0,011	mg/L (ppm)
Nitratos (NO3)	14,682	mg/L (ppm)
Resíduo seco	0	mg/L (ppm)
Zinco (Zn)	0,006	mg/L (ppm)
Sólidos dissolvidos totais	0	mg/L (ppm)
Bário (Ba)	0,189	mg/L (ppm)
Estrôncio (Sr)	0,033	mg/L (ppm)
Bicarbonato de	11,03	mg/L (ppm)
Alcalinidade de Carbonato	0	mg/L (ppm)
Alcalinidade de Hidróxido	0	mg/L (ppm)
Silício (Si)	13,1	mg/L (ppm)
Bromo (Br)	0,026	mg/L (ppm)

Gráfico de evolução de condutividade elétrica



Intervalo: 27/6/2012 ate 24/6/2019

CPRM
Serviço Geológico do Brasil

RIMAS
Rede Integrada de Monitoramento das Águas Subterrâneas

Principal
 Apresentação
 Visualizar Mapa
 Pesquisa
 Créditos
 Informações Complementares

Total de Poços Cadastrados: **409**

Atualizado em : 09/04/2021

Visualizado somente no Internet Explorer 6 ou superior, ou Firefox Mozilla 2 ou superior. Melhor visualizado em 1024 x 768 pixels. Solicitamos que as críticas, dúvidas e sugestões sejam encaminhadas ao [SEUS](#)

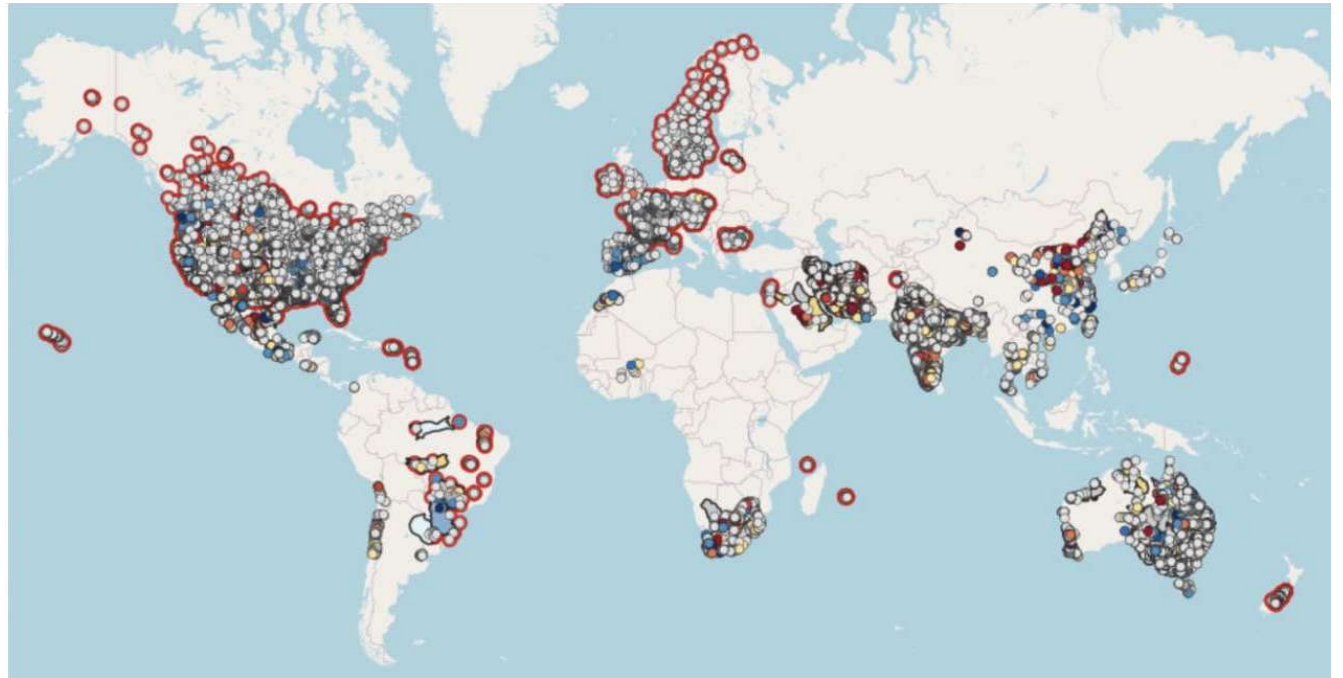
<http://rimasweb.sgb.gov.br/layout/>

CPRM
Serviço Geológico do Brasil

RIMAS
Projeto Rede Integrada de Monitoramento das Águas Subterrâneas

Principal
 Apresentação
 Visualizar Mapa
 Pesquisa
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- [O que é a RIMAS?](#)
- [Quem são os Principais Usuários do RIMAS?](#)
- [Como posso utilizar o RIMAS WEB?](#)
- [Folder do Projeto](#)
- [Proposta Técnica do Projeto](#)
- [Coleção de Relatórios-Diagnóstico dos Aquíferos Sedimentares do Brasil](#)
- [Esclarecendo Dúvidas](#)





Some Considerations



- **Frequently review objectives;**
- **Ensure quality and trust in data (chain of custody);**
- **Maintenance of good infrastructure;**
- **Training and updating teams;**
- **Apply the data/results;**

Hard work!



THANK YOU

e-mail: daniele.genaro@sgb.gov.br



MINISTRY OF
MINES AND ENERGY

