Groundwater@Global Palaeoclimate Signals 2012-2016

G@GPS
is an inclusive group of scientists interested in palaeogroundwater research.

G@GPS receives seed-funding from the following international organizations:

International Geoscience Programme

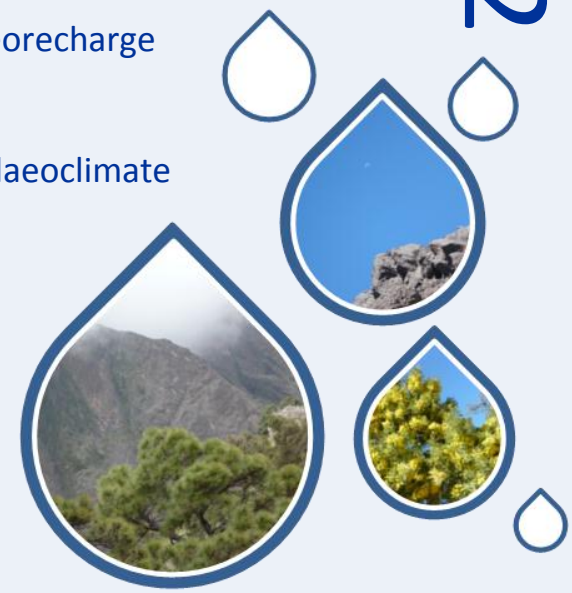
International Union for Quaternary Research

UNESCO – International Hydrological Project

The aim of G@GPS is to interpret links between palaeoclimate archives and palaeogroundwater observations at continental and intercontinental scales.

This is done through:

1. Correlation of isotopic and geochemical data from aquifers on regional and global scales
2. Discussions about methods for the study of palaeorecharge conditions and groundwater ages.
3. Correlation of groundwater palaeosignals and palaeoclimate signals from higher resolution terrestrial records.



Newsletter 1, 2012

Organization

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G@GPS Membership

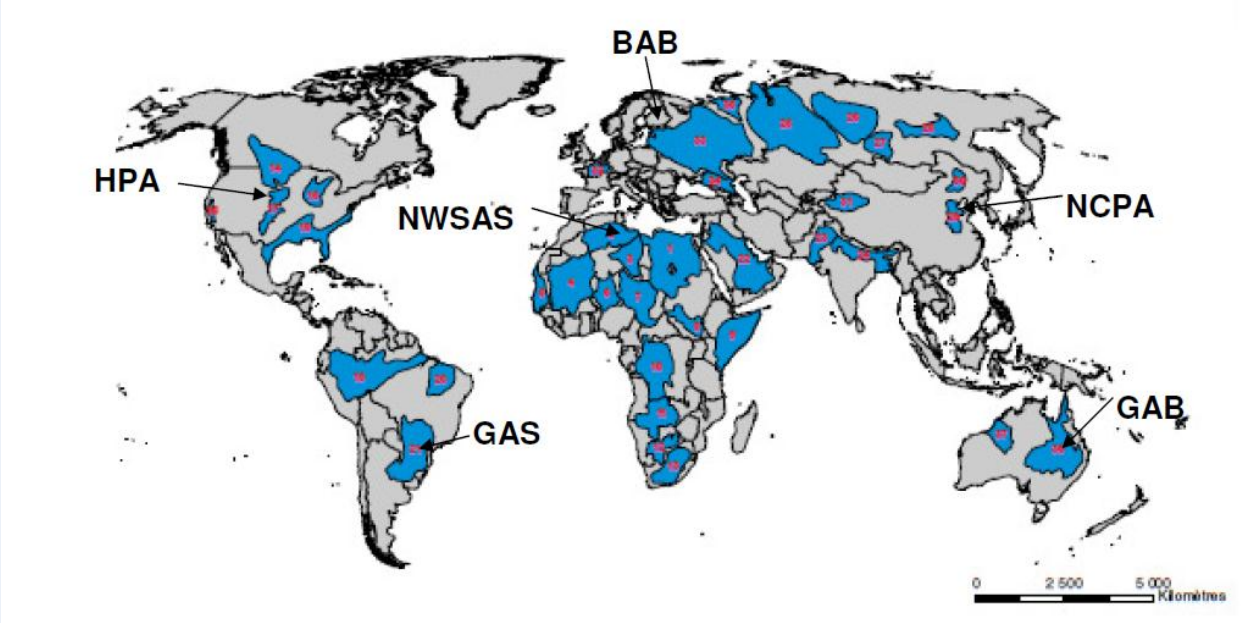
G@GPS is an open research network. Everybody interested in palaeogroundwater, isotope and dating techniques of groundwater is welcome to participate.

More than 60 scientists already participate in GPS.

To become a G@GPS participant or to receive the list of participants, please contact Dr. Martine van der Ploeg: martine.vanderploeg@wur.nl

G@GPS Basins

The success of G@GPS is dependent on data collected during research projects in groundwater basins on different continents.
These are the first groundwater basins registered as G@GPS ”flag basins”:



Africa: North West Sahara Aquifer System (NWSAS).

The most important water resource in the whole desert and semi-desert area of North Western Sahara is the NWSAS covering an area of over 1 million km^2 and shared between Algeria, Libya and Tunisia. This large, multilayered hydrogeologic system has important water reserves (~30,000 km^3) which are, however, mostly non-renewable and not fully exploitable. A recent survey of the basin showed alarming withdrawals of 2,2x109 m^3/y. With increasing population and enhanced water needs, the pressure on groundwater is expected to accentuate.

America:

In *North America* we will target the High Plains Aquifer (HPA),

with a surface of ~450,000 km^2. This is the most intensively used groundwater resource in the U.S., producing almost twice the volume of water than any other U.S. aquifer. Use of groundwater from the HPA has been at the cost of alarming rates of drawdown in the aquifer.

In *South America*

we will target the Guaraní Aquifer System (GAS), which constitutes one of the world’s most important fresh groundwater reservoirs with water volumes of ~40,000 km^3. This aquifer is shared between 4 countries (Argentina, Brazil, Paraguay and Uruguay) with different levels of groundwater usage.

Asia: The North China Plains Aquifer (NCPA)

with a surface of ~120,000 km^2 supports 11% of China's population and 14% of its arable land. Isotopic analysis of ^{18}O, deuterium, ^{3}H, ^{36}Cl and ^{14}C have been used in NCPA to identify the groundwater age, continental effect, layering or stratification and environmental change , while noble gases have been used to differentiate the impacts of Monsoon intensity and temperature.

Europe: The Baltic Artesian Basin (BAB)

with a surface of ~480,000 km^2 is one of the largest artesian basins in Europe. It fully covers the territory of Latvia, Lithuania and Estonia, parts of Poland, Russia, Belarus as well as a large area of the Baltic sea, including the island of Gotland. The BAB is a multilayered and complex hydrogeologic system. The Cambrian-Vendian aquifer system (C-V) of the BAB has been extensively studied using isotopic and geochemical tools. Studies show that the groundwater in this system has the lightest known isotopic composition in Europe (δ^{18} O values of ~-22‰). ^{3}H, ^{14}C, ^{18}O, ^{13}C, ^{39}Ar, ^{4}He, $^{40}Ar/$, ^{36}Ar, noble gas (Ne, Ar, Kr, Xe) concentration have been measured for calculations of recharge temperature, amount and composition of extracted gases.

Oceania: The Great Artesian Basin (GAB) and the coastal Sydney Basin aquifers.

The GAB (~1,700,000 $km^{2)}$ has been extensively studied and has been the benchmark were the most important age tracer studies in the last ~30 years have been initially tested ($^{36}Cl/Cl$, ^{81}Kr, ^{129}I and ^{4}He, respectively). The GAB covers approximately 22% of the Australian continent and it is the only water supply for extensive areas of the arid interior. The Sydney basin aquifers (SBAs) constitute a number of separate aquifers within the same geological units, covering a surface of approximately 17,000 km^2. This will be used as a pilot basin to assess other controls (i.e.: orography, rain shadows, etc.) and their effects on potential palaeogroundwater climatic signals.

New G@GPS aquifers

In areas not covered by the present "flag basins" new aquifers can be included during the whole project period. This concerns large basins as well as smaller aquifers with a "palaeosignal" potential. It is in particular important to include coastal systems, which can be used to identify the impact of sea-level fluctuations in the past.

Those who wish to register new G@GPS aquifers can contact one of the project leaders.

Laboratory Research co-operation

G@GPS includes collaboration between laboratories involved in the study of groundwater residence times, recharge palaeoclimate and impact of sea-level fluctuations on groundwater:

The following laboratories have confirmed that they will take part in the analysis of samples from the already established G@GPS "flag basins"

Australia:

ANSTO (Australian Nuclear Science and Technology Organization)

Located in Sydney, Australia is a major research centre in the Southern Hemisphere. At present two Accelerator Mass Spectrometers (AMS) are available (Start 2MV and Antares 10MV). Two new accelerators have been commissioned for construction in the next 3 years. This type of facility is vital for the aim of G@GPS and will allow analysis of radioisotopes used to determine groundwater residence time (age). In particular 14-carbon in both inorganic and organic samples and 36-Chloride are analyzed. ANSTO also has low level analysis of tritium (^{3}H) and a number of more common techniques e.g.: ICP-MS, ICP-AES, IRMS, IC, etc.

UNSW, CWI

CWI has three differential GPS systems, electromagnetic (EM31), resistivity (ABEM Terrameter LS), CG-5 Gravity meter, SNT28-0051 RiverSurveyor M9, Raman spectra DTS Fiber-optic system (ORYX), a wide range of Geovista downhole logging tools, and a Geoprobe 7822 for installing new piezometers. Accessory to the Geoprobe is an in-flight hydraulic profiling tool (HPT) and a continuous resistivity tool. Technical support within the CWI includes a technical officer based at the UNSW Wellington Research Station (with drilling licence), a drilling supervisor, and two geophysics technicians.

Estonia:

Isotope-paleoclimatology Laboratory, Institute of Geology at Tallinn University of Technology

Located in Tallinn, Estonia. This labs counts with an IRMS Delta V Advantage, an universal tool for isotope ratio determination of $^{13}C/^{12}C$, $^{15}N/^{14}N$ and $^{18}O/^{16}O$, in dual inlet and continuous flow modes with peripherals which include GasBench II for $\delta^{13}C$ and $\delta^{18}O$ in carbonates and δD and $\delta^{18}O$ in water), TC/EA with liquid injector (δD and $\delta^{18}O$) and with autosampler for organic samples (δD and $\delta^{18}O$), Flash EA 1112 ($\delta^{13}C$ and $\delta^{15}N$ from organic samples) and interface ConFlow III. For express analyses (with enhanced productivity of δ D and δ ^{18}O in ice core this lab counts with a Picarro Isotopic Water Liquid Analyzer, L1102-i Quantulos 1220 for Radiocarbon dating.

China:

School of Geography Sciences and Planning Sun Yat-sen University, Guangzhou

This lab will support sampling in the NCPA where an extensive network of well is available, some funded by the University. The lab will provide sampling equipment (e.g. appropriate pumping equipment), consumables for sampling, field analysis and hydrochemical characterisation of the samples (i.e. IC, ICP-MS).

Switzerland:

Climate and Environmental Physics (CEP) Laboratory, Physics Institute, University of Bern

CEP has long lasting experience in the application of radio-noble gases in environmental research. In collaboration with Argonne National Laboratories (USA) this laboratory will provide access to the analysis of 81-Krypton, a technique that is at the cutting edge of hydrological research. 39-Ar measurements will complete the dating range between modern waters and the 14C age scale.

The Netherlands:

Soil physics, Ecohydrology and Groundwater Management Group, Wageningen University

This group has access to an extensive modeling suite, including finite-difference MODFLOW/GMS (including SEAWAT), finite-element MICROFEM, Finite-Element Simulation Model for Saturated-Unsaturated Fluid-Density-Dependent Ground-Water Flow with Energy Transport or Chemically-Reactive Single-Species Solute Transport (SUTRA), a computer framework for composing (geo)chemical speciation and mass transport models ORCHESTRA (Objects Representing CHEmicalSpeciation and TRAnsport models) including a DOC module, HYDRUS 2D, a software package for simulating water, heat, and solute movement in twodimensional variably saturated media, and SWAP (Soil, Water, Atmosphere and Plant) that simulates transport of water, solutes and heat under unsaturated/saturated conditions.

USA:

San Francisco State University, Department of Geosciences, Hydrogeology and Water Resources Group, Water Quality and Soil Laboratory

This lab has agreed to run 500 Ion Chromatography (IC) water analyses (major anions/cations).

A first step is to build databases for palaeogroundwater-relevant data from all individual GPS-basins

New G@GPS laboratories

All laboratories working with isotopic and geochemical analysis of groundwater and centers for groundwater modeling are welcome to register as members of G@GPS. The aim of the collaboration is to improve the methods and to increase the understanding of palaeogroundwater flow.

Those who wish to register new G@GPS aquifers can contact one of the project leaders.

Planned activity in 2012

The first year of operation will be mostly centered on organizational tasks.

- The first Workshop will be held in September in Niagara Falls, Canada,
- A project brochure with invitation to participate in the project will be distributed at important international meetings.
- A web page will be established at one of the project leaders' institutions, with links to it from the INQUA web.
- The first electronic newsletters will be distributed (the aim is to distribute 3 per year).
- The recruitment of new members, in particular young scientists, students and from continents that are not well represented today (see Appendix 1) will continue.
- Increasing the number of G@GPS aquifers (e.g. Sub-Sahara Africa, Middle East, the Arctic, Western Australia).

Scientific work in the present "flag basins" (funding for field work and analysis is already in place):

- Monitoring earlier collected data. All available bibliographic datasets will be processed with common criteria. A database will be made initially for each basin with continental leaders responsible for this task. Work has commenced in that direction in a number of basins (e.g. BAB, GAB, HPA, NCPA and SBAs)
- Identify gaps in the data records for the "flag basins" and identify where analytical resources can be better applied. Decide and organize logistics for sample collection (these activities will be funded from existing projects at this stage).
- BAB (Europe): $^{14}C_{DIC}$ will be completed in groundwater from the Cambrian-Vendian aquifer of Northern Estonia. New samples will be collected for total gas content and gas composition analysis. New samples will be collected for noble gas (Ar, Kr) analysis, including ^{81}Kr.
- GAB (Oceania): Groundwater in the headwaters of the GAB, particularly in SE-Queensland ,has commenced with analysis of samples collected in 2011. Samples will be analyzed for $^{14}C_{DIC}$, and all hydrogeochemical parameters during early 2012.
- HPA (America)**:** During 2012, on-going recharge monitoring and age dating will continue at the HPA unsaturated-zone research network. G@GPS has access to the most comprehensive HPA dataset of groundwater quality, isotopes (H, B, C, N, O, S, Sr), and age data ($^{14}C_{DIC}$, dissolved gases (He, Ne, N_2, Ar, O_2, CH4), and ^{3}H, CFCs, SF_6), which has been collected during the HPA study.

Additional G@GPS-relevant activity

All G@GPS members are encouraged to register their own planned research G@GPS-related activities for 2012

Meeting in 2012

Date and Time: Saturday, September 22, 2012, 8:30 am to 6:00 pm
The day after the 39th IAH Congress in Niagara Falls, Canada, http://www.iah2012.org/index.php)
Registration: Jason J Gurdak: jgurdak@sfsu.edu
Economic support: A small economic support can be obtained for scientist interested in staying for the G@GPS meeting. This could cover accommodation expenses for the extra day stay. Preference will be given to students and participants from low-economy countries.
Contact Dioni I Cendon for expressions of interest.
Venue: Sheraton on the Falls Conference Center, Niagara Falls, Niagara Falls, Canada
http://www.sheratonnonthefalls.com/
Online hotel room reservations: http://www.iah2012.org/conference_centre.php

Agenda draft

Opening Remarks and Overview (8:30 am – 9:00 am)
Opening Remarks and Introductions (Jason Gurdak)
Introduction and Overview of G@GPS

Flag Basin Talks (9:00–12:15)

- Overview of study area, prior work, available data/papers, knowledge gaps, etc
- Discuss how basin complements and expands on G@GPS's Mission

Africa flag basin – North West Sahara aquifer system (NWSAS)
America (North America) flag basin – High Plains aquifer
America (South America) flag basin – Guarani aquifer system
Asia flag basin – The North China Plains aquifer
Europe flag basin – The Baltic Artesian Basin
Oceania flag basin – Great Artesian Basin

Lunch 12:15–1:30

Partner Organizations – Brief Overview and Update of Activities (1:30 pm –1:50 pm)
UNESCO-GRAPHIC , INQUA

Discussions – G@GPS The Way Forward (1:50 pm – 5:30 pm)
Mission/Goals/Objectives of G@GPS

- Establish work teams
- Begin planning the publishing of coordinated papers

Future Seminars, Workshops, Training Courses

- Announcement: 2nd G@GPS meeting 2013 – Mozambique
- Announcement: G@GPS session at AGU 2012 – San Francisco, US
- Announcement: G@GPS session at EGU 2013

Funding Opportunities (current/potential)
Communication: Web site; Newsletter

Wrap Up (5:30 pm – 6:00 pm)
Summarize Next Steps
Review Action Items
Concluding Remarks

Other Planned meetings:

2013:

Maputo, Mozambique (February)

Main responsible coordinator: Sylvi Haldorsen

Local organizers: Fatima J Momade and Achimo Mussa

Training course: Methods for Assessing Impacts of Climate Change and Human Activities on Groundwater Resources – focus on sub-Sahara Africa

Organizing the meeting in Mozambique will help researchers in neighboring countries to attend. We will secure funding for a number of scientists from different low-economy countries. The following topics will be covered during the training course, a number of the modules being the same as used in the successful GRAPHIC - INQUA Palaeogroundwater project in China, October 2011:

-Water balance studies of large aquifers
-Large transboundary aquifers
-Techniques of groundwater dating
-Stable isotopes and the calculation of recharge
-Sampling and analysis
-Modelling approaches
- Field trip to a local aquifer, with discussion about a possible new basin project

Workshop:

• Presentation of data from all G@GPS basins.
• Presentation of data from "newcomer" countries and new G@GPS aquifers.

EGU General Assembly (7-12 April), Vienna, Austria

American Geophysical Union (AGU) Fall meeting, San Francisco, CA USA (December)

2014:

Santa Fe, Argentina

Workshop and training course

Main responsible project leader: Ofelia Tujchneider

This will be a great opportunity to discuss advances on the Guaraní basin in detail. Moreover, access to a groundwater research station tapping into the Guaraní aquifer is possible.

The workshop and training course will be organised in Santa Fe (Argentina) coinciding with the Argentinian Group of the International Association of Hydrogeologists meeting. This group organises a National Congress with neighbouring countries discussing new issues in groundwater in the region. This will be a great opportunity to discuss advances on the Guaraní basin in detail. Moreover, access to a groundwater research station tapping into the Guaraní aquifer is possible.

The training course will use many of the same components as the one in Mozambique.

2015:

Tallin, Estonia

Main responsible coordinator: Rein Vaikmäe

Many of the objectives set up for the BAB basin should be close to completion and will be presented. Plans for the continuation of the project after mid-2015 to be discussed.

Japan, INQUA Congress

Main responsible coordinators: Dioni Cendon and Sylvi Haldorsen

A separate G@GPS session will be proposed, with presentation of all main results from the project.

2016:

Australia: closing meeting

South Africa: International Geological Congress

Presentation of papers

Some recent G@GPS-relevant literature

Corcho A., Leuenberger M., Kipfer R., Purtschert R. (2011). Late Pleistocene-Holocene climate variations over central Europe reconstructed from groundwater. *Quaternary Science Reviews* 30, 3423-3429.

Darling W.G. (2011). The isotope hydrology of Quaternary climate change. *Journal of Human Evolution* 60, 417-427.

Green T.R., Taniguchi M., Kooi H., Gurdak J.J., Allen D.M., Hiscock K.M., Treidel H. and Aureli A. (2011). Beneath the surface of global change: Impacts of climate change on groundwater. *Journal of Hydrology*, 405, 532-560.

Haldorsen S. and Treidel, H. (2012). Palaeogroundwater dynamics and their importance for past human settlements and today's water management. *Quaternary International* 257, 1-3.

Hughes C.E., Cendón, D.I., Johansen, M.P. and Meredith K.T. (2011). Climate Change and Groundwater. In: Jones J.A. (ed): Sustaining Groundwater Resources, 97-117. Springer, The Netherlands.

Jiráková H., Huneau F., Celle-Jeanton H., Hrkal Z. and Le Coustumer P. (2011). Insights into palaeorecharge conditions for European deep aquifers. *Hydrogeology Journal* 19, 1545-1562.

Meredith K., Cendón D. I., Pigois J.-P., Hollins S., and Jacobsen G. (2012). Using ^{14}C and ^{3}H to delineate a recharge 'window' into the Perth Basin aquifers, North Gnangara groundwater system, Western Australia. *Science of the Total Environment* 414, 456-469.

Trabelsi R., Abed K. and Zouari K. (2012). Geochemistry processes of the Djeffara palaeogroundwater (South-eastern Tunisia). *Quaternary International* 257, 43-55.

Warren W.W. (2011). Source of paleo-groundwater in the Emirate of Abu Dhabi, United Arab Emirates: evidence from unusual oxygen and deuterium isotope data. 19, 155–161.

More information about G@GPS:

A G@GPS web page will soon be established by Jason J Gurdak. In the meantime G@GPS news will be published on the INQUA Palaeogroundwater website: http://inqua.umb.no