



Groundwater@Global Palaeoclimate Signals 2012-2016

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



International Geoscience
Programme



International Union for
Quaternary Research



UNESCO – International
Hydrological Project

G@GPS Membership

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

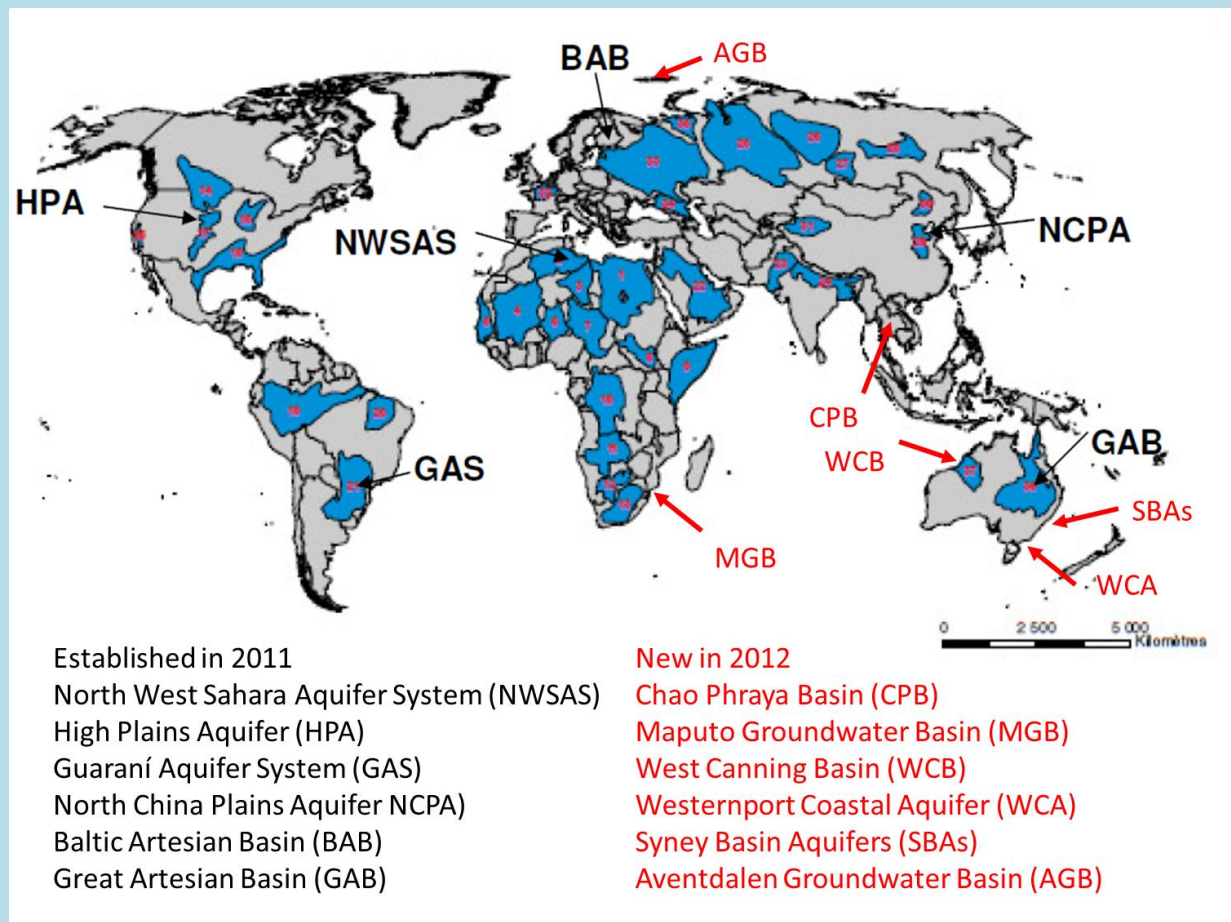
More than 70 scientists already participate in GPS. Please feel free to distribute this newsletter to colleagues who may be interested.

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

Newsletter 3, 2012



Report of G@GPS activities in 2012



Map of large aquifers of the world (modified after Atlas of Transboundary Aquifers, UNESCO-IHP, 2009). Indicated are the established aquifers in 2011, and the aquifers added in 2012. Note that some aquifers are smaller in size, and location is given approximately.

Africa: The Mozambique Groundwater Basin was registered as a new G@GPS Basin in November. This is an important drinking source for the Maputo District, where the population and water consumption is fast growing. The basin consists of an upper phreatic and a lower confined to semi-confined aquifer. Major inclusions of saline groundwater are found in both aquifers, but most prominently in the lower confined aquifer. This is assumed to be remnants from an old seawater intrusion during a sea level higher than today. The Maputo Basin is a downstream part of the transborder Incomati Groundwater Basin, shared with Swaziland and South Africa. The general geochemistry is analysed on a regular basis. There is a need for isotopic studies, which have so far not been done in the basin.

Asia: Groundwater recharge rates in the North China Plain (NCP) deep aquifer are lower than abstraction due to intense irrigation. This has resulted in water level drops in the last 20-30 years. Palaeoclimatic change signals from NCP groundwater are being used to assess past recharge rates. The increase of temperature and possibly decrease in the monsoon

intensity contributed to increasing $\delta^{18}\text{O}$ in the NCP in the past 30-40 k. Noble gases were found to be useful to differentiate these two factors. Frequency analyses of palaeoclimatic signals from NCP were carried out with main frequency of around 15000-16000 yr obtained. Considerable efforts have been made to extend the methodologies and gathering of data to other basins in Asia. We have engaged researchers from Thailand to study the Chao Phraya basin (CPB). This is the most important basin in Thailand covering 30% of Thailand's land area and generating 66% of its Gross Domestic Product. Previous work by Sanford and Buapeng (1996) shows that ^{14}C and $\delta^{13}\text{C}$ analyses indicate that groundwater in the Bangkok area is about 20,000 years old so may hold palaeoclimatic information from the time of recharge. A full grant application was submitted in 2012 to the Asian-Pacific Network for Global Change Research.

Europe: The carbon isotope chemistry was investigated in detail in the Baltic Artesian Basin (BAB). This has allowed to identify sources and sinks of carbon and extrapolate them to ^{14}C groundwater ages determinations. It was found that the formation of dissolved inorganic carbon (DIC) in the Cambrian–Vendian groundwater has been influenced by the dissolution of carbonate mineral cement in the water-bearing siliceous rocks, and bacterial SO_4 reduction, during which isotopically depleted C was added to DIC. The corrected radiocarbon age of groundwater suggests that infiltration occurred not earlier than 14,000–27,000 yr BP, which is coeval with the advance and maximum extent of the Weichselian Glaciation in the area.

To increase temporal resolution and the extent of paleoclimatic signals from the BAB a tracer (^{39}Ar , ^{85}Kr and ^{81}Kr) analysis program was undertaken during late 2012 in groundwater from deep wells in Estonia, Latvia and Lithuania. This should allow the estimation of groundwater residence times up to 1 million years. The samples are currently in processing at Bern University and in the Argonne National Laboratories in USA for Atom Trap Trace Analysis (ATTA). For more information: Raidla, V., Kirismäe, K., Vaikmäe, R., Kaup, E. and Martma, T. 2012. Carbon isotope systematics of the Cambrian-Vendian aquifer system in the northern Baltic Basin: Implications to the age and evolution of groundwater. *Applied Geochemistry* 27(10): 2042-2052.

North America: New logistic regression models were developed using data from 17 principal aquifers of the U.S., including the High Plains aquifer, to identify important source, transport, and attenuation factors that control nonpoint source nitrate concentrations greater than relative background levels in recently recharged groundwater (defined using $^3\text{H} > 0.3 \text{ TU}$) and were used to predict the probability of detecting elevated nitrate in areas beyond the sampling network. Results indicate that dissolved oxygen, crops and irrigated cropland, fertilizer application, seasonally high water table, and soil properties that affect infiltration and denitrification are among the most important factors in predicting elevated nitrate concentrations. Important differences in controlling factors and spatial predictions were identified in the principal aquifer and national-scale models and support the conclusion

that similar spatial scales are needed between informed groundwater management and model development.

Oceania: The first compilation of groundwater ^{14}C ages in Australia revealed different distributions for the north part of the continent affected by monsoons (summer rain) and the southern (winter rain). This study provides a low resolution groundwater recharge history over the last 30,000 years. Work in the Great Artesian Basin (GAB) centred in two aspects: A) Recharge to the headwaters was investigated in the Lockyer valley (QLD). This area suffered important flooding in January 2011 with over 20 casualties. This work has quantified the extent of recharge after the flooding and its outcome is very important for future management of a vital agricultural production area. B) Palaeoclimatic signals derived from groundwater across the GAB were analysed by frequency analysis with results showing a ~ 15000 yr cycle, similar to those found in the NCP.

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Westernport coastal aquifer (Victoria) was one of the first to be developed in Australia and represents an important agricultural production area for the city of Melbourne. Groundwater extraction has modified the aquifer from artesian to generate a depression cone around the irrigation areas. Research has shown the old nature of the groundwater, confirmed by ^{14}C and water stable isotopes. Salinization of groundwater close to the coast appears linked to leakage from the ocean but connate salts related to Quaternary fluctuating sea-level changes cannot be ruled out at this stage.

The West Canning Basin (Pilbara) is the second largest sedimentary basin in Australia with artesian groundwater in the area being the only reliable water source. The first round of samples was taken in June 2012. Preliminary results show an increasing groundwater age towards the ocean. This study will provide needed datasets in the monsoon dominated area of Australia.

South America: The Guarani Aquifer System (GAS) is shared with Argentina, Brazil, Paraguay and Uruguay. Its total area is $1,087,879 \text{ km}^2$, of which approximately 21% is located in Argentina, 68% in Brazil, 8% and 3% in Paraguay and in Uruguay, respectively. The outcrops areas are composed by sandstones and they are located at the edges of the GAS. This area covers $124,650 \text{ km}^2$, and there are both recharge (67%) and groundwater discharge (33%). In such huge system there are also different hydrogeological environments. For these reasons, during 2012, the Latin American Team has been working on the analysis of existing information and identifying the gaps.

Registration of new G@GPS aquifers

In areas not covered by the present G@GPS 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 Dioni Cendón (dce@ansto.gov.au).

Report of the first G@GPS meeting in Niagara

The first IGCP-618 meeting was scheduled to coincide with the 39th International Association of Hydrogeologist (IAH) meeting. This encouraged members to participate with the incentive of also disseminating our work to the wider IAH audience. The meeting also reinforced our connections with GRAPHIC (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change) part of UNESCO International Hydrological Programme with all members of the IGCP-618 invited to participate in the GRAPHIC meeting that was scheduled in the same room and immediately after IGCP-618.

Summary key achievements:

- 1) Agreed on the name of the group in which IGCP-618 is included, G@GPS (Groundwater@Global Paleoclimatic Signals).
- 2) Presented our webpage (<http://www.gw-gps.com/>).
- 3) Discussed new funding initiatives in Europe particularly UK
- 4) Discussed increasing links with agencies like IAEA
- 5) Discussed the convenience of increasing number of basins
- 6) Discussed the possible G@GPS shared session at the IAH 2013 in Perth, Australia
- 7) Discussed a potential review publication on G@GPS rather than individual basin publications

Outcome of Meeting

1. Workshop presentations highlighted progress in the flag basins.

2. The G@GPS initially setup one “Flag Basin” in all inhabited continents. However, this was perceived as quite restrictive and decided that smaller basins can contribute as much to a wider understanding of climate and links to recharge processes and therefore groundwater. Some of the samples considered included the Maputo Groundwater Basin (Mozambique) or the West Canning Basin in Western Australia.
3. The emphasis of the G@GPS group in Africa for 2013 was agreed and there was a discussion on how to offer effective funding to maximize the number of students and early career researchers. The main expenses will be in transport to Bobole (Mozambique) but accommodation should be quite affordable.
4. It was agreed to organized a shared a session with G@GPS and palaeoclimatic studies at the 40th IAH in Perth, Australia. This is underway and Palaeohydrology has been incorporated in the topics for the conference. The call for abstracts is now open, and closes at the end of February, and can be found here: <http://iahcongress2013.org/abstracts.php>
5. Most of the work discussed was also presented in the sessions during the conference with full IGCP-618 acknowledgement. We had important level of interest and new requests to form part of the G@GPS. Here are mentioned some presentations as examples:

Cendón D.I., Markowska M., Chen J. van der Ley M., Hughes C., Larsen J. (2012). Distribution and temporal variations in palaeo-groundwater on the Australian continent, 39th IAH-International Association of Hydrogeologists Congress, 16-21st September 2012, Niagara Falls, Canada. Abs398 In Congress Program and Abstracts, p. 53.

Currell M.J., Cendon D.I. (2012) Improving conceptual models of groundwater flow, recharge and quality evolution in a vulnerable coastal aquifer subject to rapid land/use change, 39th IAH-International Association of Hydrogeologists Congress, 16-21st September 2012, Niagara Falls, Canada. Abs414 In Congress Program and Abstracts, p. 301.

G@GPS Meeting 2013: INQUA-IGCP-GRAPHIC Workshop and Training Course 14-19 Oct 2013 Bobole, Mozambique, Venue: Casa Lisa Lodge

Workshop

We ask for presentations on groundwater basin dynamics, palaeogroundwater studies: isotopes, noble gases, groundwater dating methods, modeling, intrusion of old seawater. We present results from the present G@GPS basins and particularly invite studies of major groundwater aquifers in Africa, which are not at the present registered as G@GPS aquifers.

Training Course

The training course is held during the days October 4-7, with one day in the field. The course forms a M.Sc. course under the new Geoscience M.Sc. programme at the University of Eduardo Mondlane and the participants who complete the course will achieve the exam paper from the university.

- i) Climate history of Africa and predictions for the future. The lecture(s) will in particular be relevant for the understanding of past groundwater recharge.
- ii) Presentation of data from the Maputo Groundwater Basin in Mozambique. Future studies of this will be discussed, with main focus on field work and laboratory analysis.
- iii) The use of stable isotopes to estimate recharge temperatures and rates.
- iv) The use of radioactive isotopes to estimate groundwater ages.
- v) The use of other geochemical parameters to estimate recharge conditions and transit times.
- vi) Salinization processes and the identification of old seawater components.
- vii) The problem of mixed groundwater (i.e. old groundwater mixed with modern precipitation, old groundwater mixed with seawater).
- viii) Groundwater modeling, in particular modeling in data-poor areas.
- ix) Field and laboratory methods for groundwater recharge studies, with one full day in the Maputo Basin.

Transport from hotels in Maputo to Bobole will be organized in the morning of October 14th. It will be considered to organize special day-trips for accompanying members. If there is enough interest a safari in Limpopo (Kruger) National Park may be organized. There is a reasonable distance to both the eastern and the southern gate to Kruger. Please indicate your interest when registering.

Preliminary registration G@GPS annual meeting 2013
Bobole, Mozambique, October 14-19

Return to Sylvi.Haldorsen@umb.no before *May 31*

Name:

Affiliation:

Postal Address:

E-mail address:

I want to attend the workshop ___yes/no

I intend to present a paper _____yes/no

We offer to publish the presented papers in a volume of an international peer-reviewed journal

I want to attend the training course ___yes/no

I am interested in a special program for accompanying participants ___yes/no

I am interested in a post-conference trip to Kruger National Park ___yes/no

Paleo-hydrogeology: integrating paleoclimatology and hydrogeology @ IAH Congress 2013, Perth

Dear colleagues,

We would like to invite you to session 3.7, Paleo-hydrogeology: integrating paleoclimatology and hydrogeology, at the 2013 International Association of Hydrogeologists Congress, to be held in Perth, Australia on the 15-20 September.

The call for abstracts is now open, and closes at the end of February, and can be found here: <http://iahcongress2013.org/abstracts.php>

Paleo-hydrogeology: integrating paleoclimatology and hydrogeology

In many parts of the globe, we are utilising a groundwater resource which is 'fossil', with groundwater recharge occurring thousands to millions of years ago. Our use of such a resource is effectively mining groundwater, and is likely to be unsustainable. This session seeks to bring together paleoclimatologists and hydrogeologists who have an interest in groundwater-climate interactions over millennial or longer time-scales. Archives and data that would be particularly relevant to this session include: regional-scale syntheses of groundwater ages; lake archives of paleohydrology; speleothem archives of paleorecharge; aquitard porewater archives of the paleogroundwater; high temporal-resolution paleo archives of the frequency of groundwater recharge; groundwater and or climate models of millennial or longer time-scales.

Convenors:

Andy Baker, UNSW, NCGRT, and co-author of 'Speleothem Science: from process to past environments' (www.connectedwaters.unsw.edu.au)

Dioni I. Cendón, ANSTO, and Groundwater@Global Paleoclimate Signals (www.gw-gps.com; UNESCO (IGCP-618) and INQUA supported)

Feature Publications

Are you working on water stable isotopes? Have you ever used GNIP data sets to calculate Local Meteoric Water Lines? Perhaps you will be interested in the latest work of one of our members:

Hughes, C. E., and Crawford, J., 2012, A new precipitation weighted method for determining the meteoric water line for hydrological applications demonstrated using Australian and global GNIP data: Journal of Hydrology, v. 464–465, p. 344-351.

The relationship between δ^2H and $\delta^{18}O$ in precipitation at a site, known as the local meteoric water line (LMWL), is normally defined using an ordinary least squares regression (OLSR) which gives equal weighting to all data points regardless of the precipitation amount they represent. However, smaller precipitation amounts are more likely to have a lower D-excess due to re-evaporation of raindrops below the cloud-base or biases in the sampling method. In

this paper we present an equation for a precipitation amount weighted least squares regression (PWLSR) that will correct these biases for use in groundwater and surface hydrology applications. New LMWL equations are presented for Australian sites in the Global Network of Isotopes in Precipitation (GNIP), where the PWLSR consistently produces a LMWL with a larger gradient than the OLSR.

Perth and Alice Springs exhibit the largest change in slope. This is consistent with the higher frequency of small monthly precipitation amounts with low D-excess values occurring at these sites in summer for Perth and throughout the year for Alice Springs.

The PWLSR method was also applied to 288 stations in the GNIP data base ($N > 36$) and the difference between the slopes of the LMWLs ($\Delta a = \text{slopePWLSR} - \text{slopeOLSR}$) calculated for these stations. The mean change in slope, D_a was 0.12 with 56% of sites showing an increase in slope or positive D_a value and 44% having a decrease in slope or negative D_a . Sites with Mediterranean climates showed the greatest increase in slope. The magnitude of the change in slope followed some general trends showing a positive correlation with average $d2H$ and $d18O$ composition and rainfall variability, and negative correlation with period of record (N).

If you want a copy of the executable files see: <http://www.gw-gps.com/links-resources/>

White paper: Tracer Applications of Noble Gas Radionuclides in the Geosciences

The first International Workshop on Tracer Applications of Noble Gas Radionuclides in the Geosciences (TANGR2012) was held at Argonne National Laboratory on June 20-22, 2012, with support from the National Science Foundation, Argonne, and the University of Illinois at Chicago. This workshop was organized in response to recent developments in Atom Trap Trace Analysis (ATTA) that have enabled routine measurements of ultra-low concentrations of noble gas radionuclides in samples of water, ice, and gas. The workshop examined progress in ATTA, as well as applications of noble gas radionuclides to compelling scientific problems in the fields of hydrology, oceanography, glaciology, and other areas of the geosciences.

The organizers of the workshop were:

Zheng-Tian Lu, Argonne National Laboratory

Peter Schlosser, Lamont-Doherty Earth Observatory, Columbia University

William Smethie, Lamont-Doherty Earth Observatory, Columbia University

Neil Sturchio, University of Illinois at Chicago

The discussion topics and conveners were:

ATTA techniques – Zheng-Tian Lu, Argonne National Laboratory

Sample collection and purification – Neil Sturchio, University of Illinois at Chicago

Groundwater – D. Kip Solomon, University of Utah

Oceans – Toste Tanhua, University of Keil

Glaciers – Jeffrey Severinghaus, Scripps Institution of Oceanography

Volcanic/geothermal – B. Mack Kennedy, Lawrence Berkeley National Laboratory

For more information see:

<http://www.phy.anl.gov/events/tangr2012/TANGR2012%20Whitepaper%2010-09-2012.pdf>

More information about G@GPS:

www.gw-gps.com/