

International Association of Hydrogeologists
Commission on managing aquifer recharge
Report of activities in 2018



Highlights of 2018

1. A special issue (Vol 4 no 2) of J of Sustainable Water Resources Management on the theme **MAR in Integrated Water Resources Management ISMAR9**, containing 18 papers extended from presentations at ISMAR9, Mexico City 2016, was published by Springer in June 2018.
<https://link.springer.com/journal/40899/4/2/page/1> This was edited by Peter Dillon, Paul Pavelic, Weiping Wang and Adriana Palma Nava. Thanks to negotiations between IAH and Springer mediated by Dave Kreamer and James LaMoreaux, these papers are also available from the IAH-MAR web site in author-submitted form for open access. <https://recharge.iah.org/swarm-vol-4-issue-2-june-2018>
The papers include 3 papers of two IAH-MAR working groups - *global MAR inventory* (Stefan and Ansems) and Bonilla Valverde et al and *economics of MAR* (Ross and Hasnain). (Also arising from ISMAR9, Pieter Stuyfzand and Niels Hartog edited a special issue of MDPI J Water in 2017 on the theme: *Water quality considerations for MAR systems*. This has 18 papers published with Open Access. http://www.mdpi.com/journal/water/special_issues/ARS
2. On 7 September 2018, Hydrogeology Journal published a paper developed by an IAH-MAR working group *60 years history of MAR* of 31 members led by Peter Dillon and Pieter Stuyfzand. This global summary entitled *Sixty Years of Global Progress in Managed Aquifer Recharge* was published on line in the Hydrogeology Journal as an open access paper along with supplementary material- national summaries for 16 countries, and pictures and descriptions of MAR examples, supported by UNESCO as a contribution to IHP VIII. <https://doi.org/10.1007/s10040-018-1841-z>
3. An IAH-MAR Plenary was held at IAH Congress, Daejeon, Sept 2018 with 22 attendees from 10 countries. Notes of this meeting are at <https://recharge.iah.org/files/2018/10/IAH-MAR-plenary-Daejeon-10sep18-notes-AR.pdf> At this plenary a new working group on MAR suitability mapping was formed, led by Jose Bonilla (ICAA, Costa Rica) and Catalin Stefan (YU Dresden) and including Arnaud Sterckx (IGRAC), Daniel Goode (USGS), and Jana Sallwey (TU Dresden). It will identify, discuss and evaluate the range of methods in use, and is organising a workshop at ISMAR10.
4. The Commission is an active participant in GRIPP, Groundwater Solutions Initiative for Policy & Practice – led by Karen Villholth (IWMI) and jointly held a publications planning meeting with UNESCO at the Dubrovnik Congress (Sept 2017), and the New Delhi plenary (Dec 2017) resulted in a planned IAH-MAR contribution to a GRIPP activity on Groundwater-based Natural Infrastructure. GRIPP - hosted a session at Stockholm World Water Week on Groundwater Based Natural Infrastructure. A series of case studies was prepared and many members of IAH-MAR developed these. These can be accessed at : www.gripp.iwmi.org/natural-infrastructure/
5. Enrique Fernández Escalante and committees are working hard to prepare for ISMAR10 in Madrid 20-24 May 2019. A record 250 abstracts were received by 30 Nov 2018, 6 short courses and 2 workshops are on offer, several keynotes have been selected and registrations are open at the website. <https://www.ismar10.net/en/ismar10-3/> UNESCO has provided US\$5000 for travel support of early career scientists from developing countries. Applications have been processed, 15 applicants notified of outcomes and disbursements will be made at ISMAR10 by IAH Secretariat.
6. Another outcome of the publications planning meeting was the invitation from UNESCO late in 2018 for IAH-MAR to prepare a UNESCO Report on Exemplary case studies of MAR. It will be badged by UNESCO, IAH and GRIPP. This will bring together outputs of Working Groups on MAR for Sustainable Development, Economics of MAR, Global MAR Inventory, GRIPP and IGRAC. A contract was signed with UNESCO in early 2019 and a call for case studies that meet specific criteria was issued Jan 2019, and will be advanced through a meeting associated with ISMAR10 and the publication produced in Oct 2019. The invitation is extended to all to nominate worthy schemes by 20 Feb 2019 :
<https://recharge.iah.org/unesco-exemplary-mar-projects-booklet>

1. Aims of Commission

Maximizing the value of Managed Aquifer Recharge for integrated water management

The Commission promotes the securing and expanding of water resources and improving water quality in ways that are appropriate, environmentally sustainable, technically viable, economic and socially desirable. It encourages research, development and adoption of improved practices for management of aquifer recharge and improving knowledge, skills and capabilities of practitioners, water resources managers and regulators. The Commission facilitates exchange of information between members internationally (e.g. via a web page and an email list), by disseminating results of research and practical experience (e.g. via symposia and workshops), raising awareness of MAR among IAH members, related professions and the community, and through its members forming working groups to undertake projects and activities identified by plenary participants as important.

Co-Chairs: Peter Dillon (Australia) – pdillon500@gmail.com
Weiping Wang (P.R China) - wangweipingwwp@126.com
Enrique Fernández Escalante (Spain) - efernan6@tragsa.es

Web sites: <https://recharge.iah.org/> (English) Email list: – see site
: www.dina-mar.es/ (Spanish)
: <http://china-mar.ujn.edu.cn/> (Chinese)

2. Current Working Groups

1. MAR for Sustainable Development – Yan Zheng (SUST, PR China)
2. Global MAR Inventory – Catalin Stefan (TU Dresden- Germany) with Arnaud Sterckx (IGRAC, NL)
3. Economics of MAR – Andrew Ross (ANU, Australia)
4. 60 years history of MAR – Peter Dillon (CSIRO, NCGRT, WGA Aust) and Pieter Stuyfzand (KWR & TU Delft, NL)
5. Monograph on clogging and its management – Russell Martin (WGA Pty Ltd, Australia)
6. MAR to MARket – Enrique Fernández Escalante (Tragsa, Spain)
7. MAR water quality guidance and regulations – Manuel Sapiano (Malta Energy and Water Agency)
8. MAR suitability mapping – (formed Sept 2018) - Jose Bonilla and Catalin Stefan and including Arnaud Sterckx (IGRAC), Daniel Goode (USGS), and Jana Sallwey (TU Dresden). It will identify, discuss and evaluate the range of methods in use, and is organising a workshop at ISMAR10.

1. MAR for Sustainable Development – Yan Zheng

Case study fact sheets and descriptions are to be prepared for case studies that demonstrate sustainability. This will be incorporated in the planned UNESCO publication (described above in Highlights) <https://recharge.iah.org/mar-for-sustainable-development>
A MAR in the North China Plain Workshop, was held in Beijing, 17 September 2018 by Danish and Chinese collaborators in a DANIDA project : <http://www.mar-china-gues.dk>

2. Global MAR Inventory – Catalin Stefan with Nienke Ansems / Arnaud Sterckx

[IGRAC MAR Portal](https://recharge.iah.org/global-mar-inventory) – The MAR Portal now contains detailed information on 1200 Managed Aquifer Recharge sites around the world as well as several regional MAR suitability maps.
<https://recharge.iah.org/global-mar-inventory>

Two summary papers were produced and both are now available from:
<https://recharge.iah.org/swarm-vol-4-issue-2-june-2018> : Stefan, C and Ansems, N. (2018). Web-based global inventory of managed aquifer recharge applications. Sustain. Water Resour. Manag. Vol 4 (2) p153-162. <https://doi.org/10.1007/s40899-017-0212-6> (open access) - 300 reads a month since published on line !!!!!
 Bonilla Valverde, J.P., Stefan, C., Palma Nava, A., da Silva, E.B. and Pivaral Vivar, H.L. (2018). Inventory of managed aquifer recharge schemes in Latin America and the Caribbean. Sustain. Water Resour. Manag. Vol 4 (2) 163-178 <https://doi.org/10.1007/s40899-018-0231-y>

ACTION: If you have information on a MAR site that you would like included in the international set accessible at IGRAC's web site please visit the portal and complete a template of information <https://www.un-igrac.org/global-mar-inventory-site-submission-form> and submit it. Also see request in Highlights for Exemplary MAR case studies.

3. Economics of MAR – Andrew Ross

<https://recharge.iah.org/economics-of-mar>

Stage 1: 2016-18: Collection & analysis of financial (cost) data for selected MAR schemes

Stage 2: 2018 onwards: Cost effectiveness and cost benefit analysis of selected MAR schemes.

Outputs: Financial analysis of MAR costs of 21 schemes in 6 countries completed and published: Ross, A. and Hasnain, S. (2018) Factors affecting the cost of managed aquifer recharge schemes, Sustainable Water Resources Management 4:179-190

<https://recharge.iah.org/swarm-vol-4-issue-2-june-2018>

Next steps: Extension of existing work to cover a wider range of schemes with more MAR types and regions/countries (including developing countries), to analyse cost effectiveness of specific cases where alternatives to MAR have been costed to inform about the competitiveness of MAR compared with other techniques and analysis of benefits compared to costs from specific cases to provide further insights on the value and benefits of MAR.

This warrants more case studies particularly in less developed countries, and also covering cost benefit analysis of MAR projects with respect to alternative approaches to water supply, water security or water quality improvement). This is intended in the planned UNESCO publication (described above in Highlights)

ACTION: Volunteers are needed to provide economic information for MAR case studies.

4. 60 years history of MAR – Peter Dillon and Pieter Stuyfzand

A global summary having 31 coauthors was published in the Hydrogeology Journal as an open access paper supported by UNESCO (as outlined above under highlights).

Dillon, P., Stuyfzand, P., Grischek, T., Lluria, M., Pyne, R.D.G., Jain, R.C., Bear, J., Schwarz, J., Wang, W., Fernandez, E., Stefan, C., Pettenati, M., van der Gun, J., Sprenger, C., Massmann, G., Scanlon, B.R., Xanke, J., Jokela, P., Zheng, Y., Rossetto, R., Shamrukh, M., Pavelic, P., Murray, E., Ross, A., Bonilla Valverde, J.P., Palma Nava, A., Ansems, N., Posavec, K., Ha, K., Martin, R. and Sapiano, M. (2018). Sixty Years of Global Progress in Managed Aquifer Recharge. Hydrogeology Journal <https://doi.org/10.1007/s10040-018-1841-z> . At this address you can download the paper, and electronic supplementary material: national summaries for 16 countries, and pictures and descriptions of MAR examples. All are freely available thanks to UNESCO covering open access charge. The 16 countries/ areas with summaries are: Australia, China, Croatia, Finland, France, Germany, Israel, Italy, Jordan, Korea, Latin America & Caribbean, The Netherlands, Qatar, South East Asia, Southern Africa and Spain.

<https://recharge.iah.org/60-years-history-mar>

Current estimated annual volume of MAR is ~10 cu.km which is about 1% of total annual groundwater extraction but only 0.07% of natural recharge. This working group, which formed at ISMAR9, has completed its task and disbanded in Sept 2018.

5. Monograph on clogging and its management – Russell Martin

The first monograph is available (see <https://recharge.iah.org/working-groups/clogging-and-its-management>). The second volume is underway and more contributions are needed. It is somewhat optimistically aimed to complete this for ISMAR10 – Madrid May 2019

- New material - seeking papers on
 - Low cost low tech applications to reduce/manage clogging
 - MAR clogging indicators
 - standardization of investigation methods
 - case studies on management of clogging during MAR
- Synthesis of clogging papers from previous ISMAR proceedings may also be an option.

ACTION: Papers or reports on management of clogging are invited in 2018 for consideration for inclusion in Volume 2. Please contact Russell if you wish to contribute, or are aware of relevant open access material: rmartin@wga.com.au

6. MAR to MARKET – Enrique Fernández Escalante

This working group is the global channel for an Action Group under the European Innovation Partnership (EIP) named: “Strategies and actions to bring managed aquifer recharge technique to industry (MAR(solutions) to MARKET)”. This hyperactive group in association with MAR-SOL EU project (that concluded in 2017) has :

- A MAR book repository of 87 books [http://www.dina-mar.es/post/2016/12/29/ACTUALIZACION-DIC-2016-Libros-sobre-la-tecnica-MAR-\(repositorio\)-MAR-books-repository.aspx](http://www.dina-mar.es/post/2016/12/29/ACTUALIZACION-DIC-2016-Libros-sobre-la-tecnica-MAR-(repositorio)-MAR-books-repository.aspx)
- Published all outputs of MARSOL project, accessible at: <http://www.marsol.eu/35-0-Results.html>
- A linked-in network of 279 people <https://www.linkedin.com/groups/4690290>
- More information at : www.dina-mar.es/ or <https://recharge.iah.org/mar-to-market>

7. MAR water quality guidance and regulations – Manuel Sapiano

At the IAH-MAR Plenary in Dubrovnik 25 Sept 2017 a water quality guidance and regulations working group was established to assemble examples from around the world. Manuel made a contribution to the governance part of the 60 year history of MAR paper. He is preparing a paper for ISMAR10 to list and compare existing state and national water quality guidelines and regulations for MAR.

ACTION: Volunteers are invited to inform Manuel concerning the existence of such a guideline in their country to send him the web link or a copy to add to those on the web site, to allow a comparative analysis: <https://recharge.iah.org/mar-regulations>

8. MAR suitability mapping – (formed Sept 2018) - Jose Bonilla and Catalin Stefan

Founders also include Arnaud Sterckx (IGRAC), Daniel Goode (USGS), and Jana Sallwey (TU Dresden). This group will identify, discuss and evaluate the range of methods in use, and is organising a workshop at ISMAR10, May 2019.

3. MAR related activities involving IAH members

1. 45th IAH Congress, Daejeon, 10-14 Sept 2018.

There were 4 sessions dedicated to MAR in the Congress (17 papers) plus 8 MAR papers in other sessions (8) making 25 presentations and 2 poster papers on MAR. In addition there were a number of papers closely related to MAR (eg on aquifer thermal energy storage and a keynote address on injection induced seismicity) and a field trip to Korea's first bank filtration plant on Nakdong River near Changwon. The Korean Congress likely set a record for the number of MAR papers in an IAH Congress. A report on the content of selected papers related to MAR and on the field trip is found at <https://recharge.iah.org/45th-iah-congress-daejeon-korea-9-14-september-2018>



A field trip visited the Daesian Clean Water Centre, Korea's first riverbank filtration water plant, built near Changwon adjacent Nakdong River following investigations in 1997. These wells have been in operation since 2001.

2. BSMAR16, San Diego California, 5-7 March 2018.

The Groundwater Resources Association (GRA), in association with the Arizona Hydrological Society, convened the 16th Biennial Symposium on Managed Aquifer Recharge (BSMAR 16) from March 5 to 7 in San Diego, CA. This USA symposium series alternates between California and Arizona, except in 2016 when it was joint with ISMAR9 in Mexico City, and continues a close relationship with IAH-MAR.

The conference featured two training programs on recharge via wells and via spreading basins, 43 oral presentations plus posters, an exhibition, and attracted strong attendance from 10 states and seven countries. A field trip visited Carlsbad one of the world's largest seawater desalination plants. Catalin Stephan and Ralf Junghanns from TU Dresden ran a well-attended workshop to introduce the INOWAS decision support system containing free web-based simulation tools for planning MAR systems. A unique feature of BSMSAR is the presentation of the **Herman Bouwer Award** and on 6 March this was awarded to **David Pyne, who** pioneered the development of Aquifer Storage Recovery (ASR) for water storage via wells in fresh, brackish, and saline aquifers. At the GRAC San Diego Branch AGM, David Pyne and Peter Dillon, were invited to give talks, on ASR and on IAH-MAR activities, including the 60 years global progress in MAR – a paper to which David Pyne and Mario Lluria made significant contributions.



From left to right: Adam Hutchinson -Convenor BSMAR16; Andrew Stone -who presented the Herman Bouwer Award, Executive Director, American Groundwater Trust; Bob Rice - 2014 Award Recipient; Emily Black with husband David Pyne - 2018 Award Recipient; and Mario Lluria - 2016 Award Recipient.

3. Contribution to GRIPP Advances in Groundwater Governance volume

Through the work of Richard S. Evans & Peter Dillon, who authored chapter 17 *Linking groundwater and surface water: conjunctive water management*, MAR has its place within the volume prepared by a large consortium on Groundwater Governance. The book: Villholth *et al* (eds) (2018) *Advances in Groundwater Governance*, CRC Press, is now available for free down load from GRIPP and IGRAC web sites:

<http://gripp.iwmi.org/2019/01/11/book-on-advances-in-groundwater-governance-now-open-source/> and <https://www.un-igrac.org/news/open-access-book-groundwater-governance>

4. IAH-MAR Network Italy

Rudy Rossito reported that in 2018 the first two legally authorised, and recognised as such, MAR schemes entered into operations in Italy. They are the Marecchia fan infiltration basin (Emilia Romagna) and the Suvereto infiltration basin (Tuscany). The latter works in automatic mode with advanced sensing and data transmission technologies for monitoring surface- and ground-water and performing recharge operations. Capacity building activities were run by means of site visits at the Suvereto MAR plant along with the chartered order of geologists and engineers, and students of the MSc in Geotechnologies of the Univ. Siena and of the Summer School on Digital water (run at Scuola Superiore Sant'Anna, Pisa). On October the 3rd 2018 a successful workshop on MAR scheme design and construction (following the ongoing regulation DM 100/2016) was jointly run by LIFE REWAT partners and Regione Emilia Romagna at the GEOFLUID fair in Piacenza attracting about 60 active participants. Finally, a site visit for local administrators and politicians was run at the site on December 14th 2018. The Suvereto MAR scheme was also showcased in a couple of TV news broadcasts.



A field trip during 2018 at the SUVERETO recharge scheme... during natural recharge!
(Provided by Rudy Rossito, more details at <https://recharge.iah.org/mar-network-italy>)

5. IAH-MAR Network China

Simon Stisen and Yan Zheng reported a Workshop - 17-21 Sept 2018 on Development of MAR on North China Plain. The Denmark Ministry of Foreign Affairs approved a project entitled MAR in the North China Plain and this involves the Geological Survey of Denmark and a number of Chinese partners (all involved in the MAR Network China) including Southern University of Science and Technology, University of Jinan, Beijing Water Science and Technology Institute and Chinese Geological Survey. The kick-off workshop for this project was held in Beijing and included visits to field sites in Beijing and Jinan and a seminar in Shenzhen.

4. Invitation

Members of IAH and others are invited to participate in this Commission to receive and contribute news and information via our email list, to attend symposia and workshops, notably ISMAR10 in May 2019, and to join and initiate formation of working groups that produce needed specific outcomes over a finite time frame. You can join our email list from the English language website <https://recharge.iah.org/>. If you find this Commission useful, you are likely to find joining IAH as a member is also useful <https://iah.org/join-us> – through access to Hydrogeology Journal, newsletters and a wide range of Commissions and Networks, and discounted registrations to IAH Congresses and ISMARs.

Peter Dillon, Weiping Wang, and Enrique Fernández Escalante
Co-chairs IAH Commission on Managing Aquifer Recharge
7 Feb 2019