

## UNESCO-IAH Workshop on Managed Aquifer Recharge

on

### *“Inaugural Meeting of MAR-NET”*

### *Lessons from MAR experiences in India*

**Time: Thursday 10 September, 5:15PM to 8:00PM**

**Venue:** Room 101 Hyderabad International Convention Centre, the venue of the IAHS/IAH Convention (after technical sessions)

**Attendees: (38)**

<b>Title</b>	<b>Forenames</b>	<b>Surname</b>	<b>Country</b>	<b>Organisation</b>
	Roland	Andrade	India	NGRI
Dr	D K	Chadha	India	GHS
Dr	P C	Chandra	India	CGWB
	Devaraj	de Candappa	Sweden	Stockholm Env. Inst.
Dr	Peter	Dillon	Australia	CSIRO
Prof	L	Elango	India	Anna University, Chennai
	Ian	Gale	UK	BGS
	R	Guhey	India	Dept Geol, Raigun
	Prakash	Gupte	India	CGWB
	R C	Jain	India	CGWB
	Christoph	Jewell	Australia	CMJA
	B M	Jha	India	CGWB
	Akmal	Karimov	Tashkent	IWMI
Dr	Panditt	Madhinre	India	CGWB
	K A S	Manii	India	APFAMUS Project
Dr	Aslon	Mavlonov	Uzbekistan	
	A	Mukherjee	India	CGWB
	D.	Muralidharan	India	NGRI
Dr	K Md	Najeeb	India	CGWB
	P	Nandakumaran	India	CGWB
	U	Noell	Germany	BGR
	Paul	Pavelic	India/Australia	IWMI
	Didier	Pennequin	France	BRGM
	J�rome	Perrin	France/India	NGRI-IFGRC
Dr	Olez	Podolny	Kazakhstan	KazHYDEC Ltd

	Shammy	Puri	UK	IAH Sec. General
	K	Rajaiajan	India	CGWB
	A D	Rao	India	CGWB
	P N	Rao	India	CGWB
	Ranjan	Ray	India	CGWB
	A G S	Reddy	India	CGWB
	Cornelius	Sandhu	Germany	Uni. Dresden
Prof	V V J	Sarma	India	
	John	Sharp	USA	Uni. Texas
	Vladimir	Smakhtin	Sri Lanka	IWMI
	Christoph	Sprenger	Germany	FUB
Dr	Uwe	Troger	Germany	Tech. Uni. Berlin
	K	Villholth	Denmark	GEUS

The meeting began with a series of presentations on MAR focused on Indian experience and lessons and a few international speakers also made contributions. These presentations can be found [here](#).

### **1. Dr B.M. Jha, Chair of the Central Ground Water Board (CGWB)**

CGWB began experimental studies on MAR in 1976 leading to pilot projects and demonstration projects including 173 initiated between 1997 and 2008. There are reports for each of these. Guidance for project design and establishment have been produced and widely disseminated including on the web site. A master plan for MAR for India was established and mass awareness campaigns undertaken. The methods has been taken up by state governments and NGOs and included in broader catchment protection, agricultural and economic development projects. Lessons learned include the need for an integrated whole of catchment approach, need for ongoing operation and management by local authority or community, value of monitoring and possibly to better quantify the effectiveness and economic benefits that have occurred and how these vary.

### **2. Dr Muriladharan, NGRI**

Dr Murali described the constraints by nature on MAR:

- (1) there are on overage only between 1 and 12 days when daily rainfall exceeds 20mm
- (2) soil permeability – typically 3 cm/hr in the soils of AndhraPradesh, but in a place where 80cm clay was removed infiltration rates with clean water rose to 340cm/hr. There is a need ton remove silt and clay that accumulates in infiltrating basins/tanks.
- (3) high evaporation losses, which makes it important to overcome the poor permeability.

Two solutions had been tested with some success:

- (a) porous concrete berms in the streambeds of basaltic areas to trap the clays before they reach percolation tanks or infiltration structures

(b) stream length treatment to improve water quality

4) MAR has been used at the domestic scale to deal with high fluoride levels in groundwater for provision of safe drinking water supplies

### **3. Jérôme Perrin, NGRI-IFGRC**

Jerome had studied water and chloride balances in a percolation tank at Sangpur in a catchment with many such tanks. He identified two possible limitations on recharge rates, siltation of the bed of the tank, hydraulic gradient and permeability in the fractured rock aquifer beneath the tank. He found that at this site the permeability of the silt layer on the base of the tank was similar to the permeability of the aquifer and concluded siltation was not controlling infiltration rates. Chloride balance indicated an average evaporation loss of 40% of impounded water over three events in 2 years. He had done some model studies that suggested use of water for irrigation directly from the percolation tank while maintaining leakage would increase productive efficiency of use of water. Pumping from wells closer to the tank to increase hydraulic gradient would increase infiltration by more than the increase due to desilting.

### **4. K.A.S. Mani, AP Farmer Managed Groundwater System Project**

AP-FAMGS is an NGO that works with farmers, on village development where MAR is a part of a whole package. They involve community in informing, educating, data collection, do water balance estimation, identify options at various scales and structures. It generally takes 2-3 years before implementation and then monitor to see what impact occurred. In some cases this appears to be none. Water balance comparisons are done, and social and ecological benefits are identified. Opportunities and challenges are to identify downstream impacts of upstream water harvesting. These effects may be negligible or beneficial in high flow years but detrimental in dry years. There is a need to evaluate erosion control for its benefits in soil protection as well as water quality improvement and retaining infiltration rates. There are opportunities for MAR in revitalizing abandoned wells. Integrating MAR as part of total investment planning is warranted. He has developed informal educational tools eg a model of hydro/geo/logy. Developing guidelines for comprehensive impact assessment for MAR investments is warranted, covering social, economic, environmental and technical aspects. There is also a need to evaluate risks, such as water quality and health related risks.

### **5. Dr B.Venkateswara Rao**

Dr Rao raised the issue of linkage between groundwater recharge upstream and surface water discharge downstream. The more water is used upstream the less is available downstream. He reported the case of Upper Musi catchment where increases in groundwater levels in the monsoon were correlated with the depth to groundwater at the end of the dry season. Suggesting that the aquifers are acting just like a dam on the stream. Some account needs to be taken of downstream effects of MAR.

### **6. Dr A. Mavlanov (Uzbekistan) with Dr A. Akmal Karimov (Tashkent)**

Dr Mavlanov with interpretation by Dr Karimov described Central Asian experiences with MAR in the vicinity of and upstream of the Aral Sea. In one area a 10kmx3km groundwater lens salinity increased to 1500mg/L. River Darya adjacent river water varies from 600 to 1400 mg/L during the year and canals were built at Chalysch to convey water

for use and recharge at times when river flow was fresh, and freshen aquifers for use for the remainder of the year. Bank filtration was employed using wells adjacent channels. At another site in limestone adjacent the Aral Sea groundwater modeling is being performed to assess likely impact of a proposed similar scheme. Pilot studies in this area would be expensive.

### **7. Ian Gale, British Geological Survey**

Ian showed photographs of a wide variety of MAR Projects around the world describing the wide range of purposes (water supply to water quality improvement), methods, including sites in India, Nepal and Pakistan, Namibia, USA, and UK, and from scales of open wells in Rajasthan to Omdel Dam in Namibia that harvests rare large flows of turbid water and provides continuous releases of low turbidity water to infiltration ponds in the coastal delta downstream. He used Kathmandu Valley in Nepal as an example of evaluating the various possibilities for water harvesting considering the constraints on each in order to make a selection.

### **8. AP Groundwater Department Representatives**

Surface water may be used to restore depleted groundwater reserves. This is a groundwater demand management strategy. For the Srisailem Right Branch Canal of the Krishna Basin - Pennar Basin link the 14 areas now irrigated by surface water have had rising water tables whereas in another 5 areas without surface water irrigation, levels have continued to decline. Additional drainage beneath irrigation areas is increasing recharge and there may need to be a balance between groundwater and surface water use to stabilize groundwater levels.

### **9. Dr D.K. Chadha and Dr R.C. Jain**

In the state of Gujarat areas have been mapped where water is available in excess (that is non-committed surplus water), and areas suitable for MAR have been mapped where the water table is not too shallow or saline. The aim is to resaturate the zone where water depletion has occurred and avoid water logging. A 4 prong strategy is being implemented aimed at saving or generating about 5-6,000 mcm.

- (1) recharge of surface water by government (large scale)
- (2) recharge of rainwater by householders
- (3) policies to accelerate recharge
- (4) policies to support demand management.

### **Discussion**

**Q: Is dug well recharge better than percolation tanks ?** – evaporation may be reduced but scale is different. Combinations may be best. Old methods are worth adopting and adapting.

Q: Demand management – how to implement, recognising that irrigated production will need to increase. - For Gujarat the excess water has been calculated assuming flow to sea is lost. (HM flow to sea is needed for coastal ecosystems including fisheries? Storing subsurface provides for irrigation energy saving – smaller pumping head, avoidance of double pumping from wells that dry out.

## MAR-NET

At this point Ian Gale gave a brief presentation on UNESCO-IAH Network on MAR (called MAR-NET for short).

A two page flyer on MAR-NET (attached) was circulated at the meeting, addressing the objectives and proposed types of activities, membership and how people and organizations can become involved.

Peter Dillon suggested that India's huge experience on MAR provides a great knowledge base on the hydrology and hydrogeology of groundwater augmentation on which to add knowledge about water quality to enable these techniques to be used for securing and improving the safety of drinking water supplies in rural and urban India and elsewhere in the world where access to safe drinking water supplies is limited.

The discussion continued from the first part of the meeting to assess whether MAR-NET objectives were reasonable and desirable in India. This notion met unanimous support.

**Q1: Water quality** – how much is known on suitability of water quality from MAR for drinking water supplies? - In some cases MAR has been used to dilute high fluoride groundwater to below drinking water criteria. However there is a lack of data on microbial pathogens in groundwater and other aspects such as pesticides and mobilization of metals such as arsenic.

**Q2: Evaluation** – how widely used is chloride and other complementary simple methods to evaluate recharge efficiency (what proportion of captured water reaches the aquifer) and effectiveness of recharge (what impact is this having on groundwater storage and irrigated production)? Could this be put into guidance so that information can be used to provide feedback for improving siting and design of recharge facilities? – Dr Chadha informed that a publication is in preparation on optimizing recharge structures, addressing multiple structures in a watershed, and affects on flood mitigation.

**Q3: What information and resources are available on MAR and how is it disseminated?** – CGWB has a web site with Master Plan, guidelines on MAR of various types, manuals at technical level and also for farmer and community level. UNESCO, AP-FAMGS, other NGOs and state agencies also have relevant info for their locale in relevant languages. – perhaps some form of directory to these resources would be of value in helping enquirers quickly find relevant material at the right level from school resources to farmers, technical advisors, hydrogeologists and engineers, and policy people and at parliamentary level. This may also identify if there are important gaps.

**Q4: Bankfiltration** provides opportunities for drinking water supplies. How can we get new methods adapted and used? – demonstration projects are most useful and could cover a matrix of methods, hydrogeological settings, source water types and end uses, including some that may be more focused on drinking water. - Cornelius Sandhu (U Desden) proposed that the Cooperation Centre for River Bank Filtration (CCRBF) be included as a demonstration site on RBF within MAR-NET. Other possibilities included IFCGR Hyderabad for various types of MAR in hard rock aquifers, and further discussion was warranted to explore opportunities for research, education and training and building capabilities.

**Q5: Wastewater reuse for irrigation** already occurs for certain types of wastewaters and crops and could this potentially be a source water for recharge as in some other countries? – It was suggested that this could be a distant goal for drinking water supplies, but in the first instance that this be considered in relation to irrigation and industrial supplies where groundwater is not the source of drinking water. In Australia there are now guidelines that allow for recycling of all types of waters via managed aquifer recharge but achieving drinking standards may require supplemental treatments are the costs of high in comparison with producing irrigation supplies.

**Q6: Care on water allocation** is required especially where downstream catchments are involved. Perhaps drinking water could have a higher priority than other uses, as occurs in South Africa.

### **Conclusion**

The buses were waiting so we had to bring the meeting to a close at 8pm. Peter Dillon summed up that a number of opportunities to garner from and add to India's wealth of MAR experience were identified during the evening. All present expressed an interest to be involved in a MAR-NET network in India. In order to prepare some more concrete suggestions as to objectives in India and the formation of the network, all present were invited to a follow up meeting in the same room at lunchtime the following day.

Ian thanked Paul Pavelic for organizing and convening the first part of the meeting and all the speakers and those in attendance for their contributions and interest and the support shown for a strong Indian component of MAR-NET.

### ***“Inaugural Meeting of MAR-NET” Lessons from MAR experiences in India.***

#### ***Follow on meeting***

**Time: Friday 11 September, 12:30PM to 1:30PM**

**Venue: Room 101 Hyderabad International Convention Centre**

**Present:** Dr Bhanu Neupane, Dr Chadha, Mr Jain, Dr Jha, Dr Rao, Dr Pavelic, Prof Yongxin Xu, Mr Gale, Dr Sandhu, Dr Karen Villholth, Dr Dillon

At this meeting we discussed items that were raised at the IAH-MAR meeting on Tues 8 Sept, and at the MAR-NET meeting the previous evening under the categories listed on the two page brochure (but in a different order).

#### **1. Offering relevant materials, videos, slide sets etc for use in training programs**

Dr Jha offered that the materials on the CGWB web site would be made available. Peter suggested a directory of the materials would be helpful, if not already on web site, so enquirers could easily access the most relevant information they needed.

(As a possible example classifying material according to following criteria and making a summary sheet that helps people find the relevant documents:

1. the target audience (eg; technical-hydrogeol/engineering), technician level agricultural advisor /NGO, farmer/community resources, school level, or policy /ministerial level resources)

2. language
3. type – document, video, slides, other
4. regional relevance –
  - a. hydrogeological domain (fractured rock, alluvial or both)
  - b. setting (urban, rural town, village, single dwelling)
  - c. type of recharge structure (percolation tanks, dug wells, bank filtration, infiltration galleries etc),
5. main message/content – siting, design, integration in other measures, catchment management, construction, operation, maintenance, evaluation, , etc

This may also help to identify communications gaps in areas where there is a strong but unmet demand.

To be determined – who to collate and index material?

Presumed that it would stay on its existing web site, but have a link to MAR-NET web site where the index would be mounted. Material by NGOs and states and others. Alternatively this gets screened and mounted on MAR-NET site.

*Needs a person to be responsible for this.*

- 2. Offering to help as a trainer** – identify expertise and topics in which willing people could provide training.

Needs thought on how this is done. – names on a web site, which could become a resource for consultants? or perhaps a register of courses already run and who has taught what in them.

- 3. Demonstration sites for training programs** – these should be well-evaluated sites where the effects of the system have been quantified.

Ideally there would be a research and training organization in close proximity to address research matters and the operators of the project are continuing to maintain and monitor the system. There should be at least a report on the project implementation and uploading of data from time to time to see how the site continues to operate as conditions change (climatic and landscape).

It is suggested a list of such sites be established indicating the type of project, and any features that would help enquirers identify the project closest in type or conditions to one they may be considering establishing.

**Action: establish a list of such demonstration projects, and put information on web.**

Identify project types where there are no demonstration sites with adequate information and seek to identify and prioritise evaluation of one or more of these

*Needs a person to be responsible for this.*

#### **4. Nominating a centre for training and capacity building**

From discussions it seemed that the collective of NGRI including IFGRC together with IWMI and NGOs, and state and CGWB could provide a sound base in Hyderabad for a centre. Peter suggested we do not establish new centres, but rather find established centres of groundwater expertise with an interest in MAR and help to foster their involvement in MAR research and training. A partnership with government organizations, for example by secondments or postgraduate scholarships to the Centre would assist in building local capability. Cornelius Sidhu again raised CCRBF as a prospective focus for riverbank filtration. IFGRC (NGRI-BRGM) Hyderabad was again raised. Dr Chadha suggested establishing an additional centre in Delhi. Number and types of Centres would be a matter for the Advisory Committee of the Indian sub-network of MAR-NET, taking account of resources needed to go into such centres, and to ensure that centres operated in a complementary non-competitive mode by having clear and non-overlapping foci. One suggestion was for hardrock and alluvial foci.

*For consideration by Advisory Committee.*

#### **5. Identifying and undertaking other roles to help advance the objectives of MAR-NET**

Other items identified in both meetings were:

- (1) Water quality in MAR For drinking water supplies – possible supplementation of existing guidelines for MAR to address water quality issues associated with use of recovered water for drinking. That could be a research activity, or be addressed in conjunction with other countries in MAR-NET
- (2) Monitoring effectiveness of MAR – a small report on practical application of methods for measuring performance of MAR projects could be produced. This may include eg chloride method for determining evaporative loss, methods for discriminating effects of variability of season from effects with and without recharge structure, methods for assessing effect of siltation on infiltration rates, measures of changes in production and value of production, measures for assessing environmental protection through MAR
- (3) Maintenance of MAR facilities – guidance based on evaluation
- (4) Whole of catchment approaches to water sharing with MAR – guidance based on evaluation
- (5) Research in support of riverbank filtration and dug well programs – monitoring and evaluation of demonstration sites leading to guidance (eg CCRBF plans)

#### **6. Identifying funding for proposals in support MAR-NET activities**

We will be looking to UNESCO to provide secretariat services to facilitate writing of such proposals and engagement with all the relevant family of UN and other organizations so that resources can be raised that are commensurate with the benefits of effective MAR for water supply security. Funding proposals will always need evidence of partners willing to provide in-kind and or cash support to facilitate projects. Where possible this will draw on funding intended to occur through existing government programs that have consistent goals. Advisory committee would have a

role in prioritising proposals to be raised by the Indian sub-network. Peter advised that an AusAID call for projects had been made and he would explore opportunities there and advise.

**Indian Advisory Committee:**

At the outset of the meeting Dr Neupane had suggested that we form an advisory committee for the Indian network within MAR-NET. At the end of the meeting all Indian members present agreed to be on advisory committee. Bhanu had suggested we revise and circulate the MAR-NET flyer listing members of advisory committee and actions in planning.

**Actions:**

- Items above provide an action list for members of the Advisory Committee of the Indian part of MAR-NET.
- Peter and Ian are to draft notes for circulation to all attendees. This will be a point of discussion with Bhanu and subsequently between Alice Aureli, Ian and Peter in Paris on 19 October. Notionally UNESCO would write letters of invitation to members of this advisory committee for MAR-NET and consider logistics of subsequent meetings.
- Meeting was closed on this positive note, and Peter thanked all for their participation and enthusiasm for the ideas and objectives which an active MAR-NET will help realise.

## APPENDIX

### Program for Meeting Thurs 10 September

#### UNESCO-IAH Workshop on Managed Aquifer Recharge

on

*“Inaugural Meeting of MAR-NET”*

*Lessons from MAR experiences in India*

**Time:** Thursday 10 September, 5:15PM to 8:00PM

**Venue:** Room 101 Hyderabad International Convention Centre, the venue of the IAHS/IAH Convention (after the close of technical sessions)

Managed Aquifer Recharge (MAR) is occurring on an unprecedented scale in India under the auspices of various programs. The expectations from MAR are great and opinions of the benefits and costs vary widely across the country. Knowledge centres are numerous and R&D on MAR is dispersed across many agencies, institutes, NGOs. This event, which coincides with the Joint International Convention of IAHS Scientific Assembly and IAH Congress, offers an opportunity for the open expression of ideas and dialogue and a way forward for the coordination of efforts in MAR, with a particular focus on developing safe and secure drinking water supplies.

A series of invited speakers from India will provide brief presentations on their experience and perspectives, which will be followed by brief talks from several other presenters. A collective discussion involving presenters and the audience will then follow. This will seek to find practical ways to share the considerable wisdom of India and elsewhere. This may include identifying an Indian node or nodes for the network of capability centres and demonstration projects and identifying ways in which MAR-NET objectives could be achieved in India.

The workshop will conclude with the playing of a video of the 3Rs (recharge, retain, recycle) book prepared for Stockholm Water Week 2009 by Albert Tuinhof and Frank Vansteenberg.

We hope you will be able to attend the workshop.

With regards,

Dr Peter Dillon, CSIRO Land and Water, Adelaide, Australia

Mr Ian Gale, British Geological Survey, Wallingford, UK

Dr. Paul Pavelic, IWMI, Hyderabad, India