

Summary report of the G-WADI workshop

# **International Training Workshop on Groundwater Modeling for Arid and Semi-arid Areas**

Lanzhou/China, June 11-15, 2007

and

## **the 2nd Asian G-WADI meeting**

Lanzhou/China, June 16-17, 2007

Xin LI & Zhuotong NAN

Sponsored by



Organized by

Cold and Arid Regions Environmental and Engineering Research Institute,

Chinese Academy of Sciences (CAREERI, CAS)

Lanzhou, China, July 2007

The International Training Workshop on Groundwater Modeling for Arid and Semi-arid Areas (hereafter “the training workshop”) under the G-WADI programme was held in Lanzhou, China, on June 11-15, 2007, followed by an Asian G-WADI member meeting on June 16-17 2007 in the same venue.

56 participants, including 9 invited experts, from twenty-two countries (Afghanistan, Australia, British, Chile, China, India, Iran, Jordan, Kazakstan, Kingdom of Saudi Arabia, Kyrgyz, Mexico, Mongolia, Morocco, Namibia, Pakistan, Spain, Sudan, Switzerland, Tajikistan, USA, Uzbekstan) attended the 5-day training workshop.



28 representatives of the Asian G-WADI members from the nine Asian member countries (Afghanistan, China, India, Iran, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, and Uzbekistan), as well as representatives of UNESCO Offices (Beijing/New Delhi/Tehran) and some members of the Steering Committee of the Global G-WADI Programme met, provided country reports and discussed various issues related to the Asian G-WADI Network.

## Scientific context of this event

Groundwater is a vital resource in arid areas, but increasingly under threat from pollution and over-exploitation. Active management of groundwater systems has the potential to increase sustainable yields and remediate pollution. The sustainable management of groundwater depends on the assimilation of complex information on aquifer properties, and the estimation of recharge, which is dependent on climate and land use and which varies in time and space. Modelling is an essential tool to understand and manage groundwater systems, but little information is available to provide guidance for the special problems of arid and semi-arid areas.

A better understanding of ground water dynamics through the proper use of groundwater modeling tools will help people to manage precious water resources in watersheds of arid areas.

The aims of the workshop are 1) to bring together the world’s leading experts in arid zone groundwater modelling to deliver a definitive set of lectures and case studies to an audience of active researchers from the world’s arid regions; 2) to draw on the experience of the workshop participants in developing this material and a ‘Lanzhou statement’ of recommendations for future activities; 3) to make this material available to the global community through UNESCO and in particular the G-WADI web-site ([www.g-wadi.org](http://www.g-wadi.org)), and 4) to stimulate follow-up activities, regionally and globally.

## Organization

Cold and Arid Environmental and Engineering Research Institute of Chinese Academy of Sciences (CAREERI/CAS) organized the training workshop and Asian G-WADI meeting. This is financially supported by IHP/UNESCO, CAREERI, and DFID UK. IHP and DFID supported the international travel costs for invited participants; CAREERI, as the local host, covered all the local costs for the

majority of participants. Only 7 participants were paid by themselves.

In the first two days, a receipt desk was set up in the lobby of the Lanzhou Hotel to make the check-in procedures easy for participants. We also requested 4 volunteers from Lanzhou University to help us in the entire duration of this event.

A welcome banquet was set up in the evening of 10th June before the opening of the event. Professor Xin Li, the banquet host, started the banquet with the introduction to all present guests. Professor Guodong Cheng on behalf of the local organizer presented a speech to welcome all distinguished guests to Lanzhou. Professor Howard Wheeler on behalf of G-WADI/IHP introduced the initiative and progress of the G-WADI programme. Professor Wei Ma on behalf of the organization institute thanked for the coming to Lanzhou. Dr. R. Jayakumar, on behalf of the UNESCO, gave the best wishes of the success and closed the addressing session.



From June 11-17, the training workshop and following Asian G-WADI meeting were held in the building of Frozen Soil Engineering of CAREERI. Accommodation was provided in the four-star Lanzhou Hotel, around 10 minutes walk from the workshop place.

A proceedings including lecture materials from experts were compiled and made available at the first day of the training workshop. CDs containing electronic copy of both lecture materials and presentations, and contact listings were made and disseminated to participants.

## Field trip

In June 15, a field trip to the Heihe River basin, the major study watershed of CAREERI, was arranged. 43 participants plus 10 local persons went to the field. Participants visited an integrated ecological and hydrological research national station, an irrigation control system, a typical reservoir for irrigation purpose, and a groundwater infiltration experiment field, as well as a “Water Saving Society” achievements exhibit.



## Technical reports of the training workshop

The training workshop started on the morning, June 11 by an introduction to G-WADI and the Lanzhou Workshop from Professor Howard Wheeler. (See appendix 1 for programme)

Prof. Howard Wheeler presented a topic on hydrological processes, recharge and surface water-groundwater interactions in arid and semi arid areas. Upon existing problems, He concluded all sources of data from surface water, groundwater and geochemistry, and integrated modelling tools must be used for assessing sustainable yields of groundwater recharge systems.

Prof. Wolfgang Kinzelbach talked about the sustainable groundwater resources management. He put

emphasis on the sustainability in the groundwater sector, model uncertainty and the recharge determination. A case study from the Yanqi basin, China was used to illustrate those issues. He concluded given sufficient system knowledge the model based analysis of a system with respect to sustainability is feasible. To be really useful, hydrological models have to be coupled to economic models.

Prof. W. Mike Edmunds introduced isotopic and geochemical methods to model recharge sequences in arid and semi-arid regions. His presentation draw a conclusion that the geochemical and isotopic measurements are of vital importance in semi-arid and arid zones due to the need to define extent of groundwater renewability.

Prof. Xusheng Wang reviewed the history of numerical modeling activities of groundwater flow in the Heihe River basin, China. By a comparison, he discussed existing issues and prospected the future development.

Prof. Craig Simmons introduced full aspects about the variable density groundwater modeling ranging from approaches, challenges to potential resolutions. Besides, case studies and applications were demonstrated to help understand the method.

Prof. Adrian Butler and Prof. Jesus Carrera modeled groundwater by Stochastic methods. Prof. Butler focused on the aquifer protection and management issues, while Prof. Carrera put emphasis on theoretical aspects as well as uncertainty issues when modeling. Prof. Carrera also discussed the importance of heterogeneity issue in groundwater modeling using a number of existing applications.

Prof. Shakeel Ahmed presented his topic on how to making aquifer modeling unbiased through application of geostatistics. He concluded a better estimation can be obtained using geostatistical approach, and a performance analysis can be achieved by using variance of the estimation error.

Prof. Abdelkader Larabi showed his work on the development and application of seawater intrusion models. He introduced relating theory, model development, benchmarking, and applications in details, ending with a seawater intrusion case study in Morocco.

Prof. Ann Maria Gangas P., Prof. Rafael Litvak and Prof. Mario R. Vieyra introduced groundwater modeling activities and progresses in their countries respectively.

After the technical session, three breakout groups were established to summarize the comments from all participants. The questions focused on: 1) What do you think are the key messages from this meeting? 2) What would you like to have seen in the groundwater modelling meeting that was not covered? And was the level of detail and technical content appropriate for your needs? And 3) What do you see as the priorities for G-WADI's future activities in the area of groundwater management at a global/regional level?

Comments and suggestion are following but not limited to:

- 1) Salinity, salt intrusion and industrialisation are priority problems. We need to work on larger regional scale for many problems and need to develop robust conceptual model of system.
- 2) Remote sensing, variable density modelling, isotope analysis, stochastic groundwater modelling are all new techniques that will be useful.

3) Better estimation of recharge rates and mechanisms in arid areas would be critical for groundwater modeling.

3) The theory was presented in an understandable manner and the case studies helped understand how these techniques can be applied.

4) Groundwater to surface water interactions, soil-water-plant processes, practical training with modeling, soil and water pollution and soil subsidence would be covered in future event. A “problem clinic” session would be helpful to tackle specialist issues in particular countries.

5) Future priorities may include water productivity and how it effects people lives, how to get a good estimate of water availability and water losses, development and sharing of data sets, and developing links between technical/modelling assessment and community/end-users. Set up G-WADI online discussion group / email list. Facilitate interaction and joint projects across countries.

## The 2nd Asian G-WADI meeting

Dr Abdin Salih, Director of UNESCO Tehran Cluster Office, welcomed delegates of the Asian G-WADI member countries as well as groundwater modeling experts to the 2nd Asian G-WADI Network Meeting. Country reports were followed.

The country report of India was presented by Ms. Sharma which mainly included: hydrological information on Rajasthan/Udaipur basin where is to be proposed as a Pilot G-WADI Basin. NIH proposed to hold the next SC G-WADI Meeting at Roorkee/India in December 2007. As per Ms Sharma, the book on the pilot Asian G-WADI Pilots will be disseminated during the above mentioned meeting.

The country report of Afghanistan was presented by Mr Eqrar with the title: water resources of Afghanistan with special emphasis on Kabul Basin.

Presentation of China Country Report by Prof Xin Li: Watershed Integrated Model of Heihe River Basin (Black River Basin).

Report on Taleghan/Iran G-WADI Pilot Basin by Dr Sharifi: General information on the water resources of Iran along with introducing hydrological processes, recharge and surface-ground water interactions studies and monitoring in Taleghan G-WADI Pilot.

Presentation on Kashafrud (Mashhad)/Iran G-WADI Pilot Basin by Mr Sheibani: developments achieved within Mashhad G-WADI Pilot Basin since the Asian G-WADI Harmonization Workshop held in New Delhi on March 2006.

Kazakhstan's Country Report was presented by Mr Polatbekov which provided general information on the situation of the water resources of Kazakhstan and problems involved in the water resources management.

Presentation on Tuul-Terelj Basin of Mongolia by Ms N. Buyankhishij where general information on the water resources of Mongolia and hydrological characteristics of Tuul-Terelj Basin was provided.

Sustainable Groundwater Management in Balochistan Province of Pakistan by Dr Sheikh: information provided on water resources management in the 5 river basins of Balochistan province.

Report on Vakhsh River Basin (VRB) in Tajikistan by Mr Normatov: general info on the hydrological characteristics of VRB was provided.

Presentation of Uzbekistan's country report by Dr Khasankhanova (Ms): general information provided on the water resources of Uzbekistan and hydrological data of Amudarya River Basin.

A report on the International fund for Saving the Aral Sea was presented by Mr Kazakov of Tajikistan which covered existing crisis within the Aral Sea, future projects and programmes, and the int'l fund for saving the Aral Sea.

Mr Neupane from UNESCO New Delhi reported on Asian G-WADI Network on behalf of the secretariat (NIH). He elaborated on constrains prevailing within NIH that hindered achieving goals set at the 1st Asian G-WADI Network Meeting. He also informed about development of a guideline for proposing Asian G-WADI Pilot Sites.

Other issues relating to Asian G-WADI were also discussed. A declaration from this Asian meeting was adopted (See appendix 2). Besides, the meeting agreed the Asian G-WADI secretariat move to CAREERI from NIH India.

July 25 @ CAREERI/CAS

## Appendix 1

### PROGRAMME of groundwater modeling for arid and semi-arid areas

#### G-WADI workshop, Lanzhou, China

11-15 June 2007

#### DAY 1 (Monday)

9.00

Welcome, Introduction to Workshop, Introduction to participants

30 mins

Howard Wheater, Xin Li, Jayakumar

Discussion on use of models with workshop participants

30 mins

Howard Wheater

Hydrological processes, recharge and surface water-groundwater interactions in arid and semi arid areas

30 mins

Howard Wheater

Tea/Coffee break (30 mins)

11.00

Groundwater modeling and management in arid and semi-arid environments 1

1 hr 30 mins

Wolfgang Kinzelbach

Lunch (1hr)

13.30

Groundwater modeling and management in arid and semi-arid environments 2

1 hr 30 mins

Wolfgang Kinzelbach

Tea/Coffee break (30mins)

15.30

Geochemical and isotopic tracers as tools for groundwater systems analysis

2 hrs

Mike Edmunds

17.30

Case Study: The Heihe river basin, China

45mins

Wang Xusheng

Dinner (18.45-)

#### DAY 2 (Tuesday)

9.00

Part 1: Variable density groundwater modelling: Approaches, Challenges and Resolutions

1 hr 30 mins

Craig Simmons

Tea/Coffee break (30mins)

11.00

Part 2: Variable density groundwater modelling: Case studies and applications

1 hr 30 mins

Craig Simmons

Lunch (1hr)

14.00

Stochastic methods for aquifer protection and management

2 hrs Adrian Butler  
 Tea/Coffee break (30mins)  
 16.30  
 Making models unbiased - applications of geostatistics; Case Studies from semi-arid granitic aquifers in India  
 1 hr Shakeel Ahmed

Dinner (18.00-)

**DAY 3 (Wednesday)**

9.00  
 Stochastic methods in groundwater modelling 1  
 1.5 hrs Jesus Carrera  
 Tea/Coffee break (30mins)  
 11.00  
 Stochastic methods in groundwater modelling 2  
 1.5 hrs Jesus Carrera  
 Lunch (1hr)  
 14.00 (tbd) 30mins Anna M. Gargas  
 14.30 CHU RIVER BASIN 30mins Rafael Litvak  
 15.30 (tbd) 30mins Mario R. Vieyra

16.00 General discussion (30mins)  
 Go back Hotel to prepare for field trip. Take your package to a safe place.

Dinner (18.00-)

21.00  
 Take train  
 TRAVEL TO BLACK RIVER VALLEY – FIELD TRIP

**Day 4 (Thursday)**

Black River Valley – field trip and return

**Day 5 (Friday)**

9.00 Development and Application of seawater intrusion models: theory, development of the model, benchmarking, and applications (1.5 hrs) Abdelkader Larabi

Tea/Coffee break (30mins)

11.0 Case Study: A full detailed seawater intrusion case study in Morocco (45 mins) Abdelkader Larabi

11.45  
 Break-out groups – workshop conclusions All

Lunch (1hr)

13.30  
 Break-out groups – workshop conclusions All

14.30  
 Break-out groups report  
 Workshop closure

Tea/Coffee break



16.00

Speakers meeting – meeting review/web publication/book publication/discussion of next steps

Dinner

## Asian G-WADI Meeting Network meeting AGENDA

16-17 June 2007

Chairman: Dr Abdin Salih

Opening Ceremony

Country reports:

Country report from India

Country Report from China

Country report from Afghanistan

Country Report from Iran

Country report from Kazakhstan

Country report from Kyrgyzstan

Country report from Mongolia

Country report from Pakistan

Country report from Tajikistan

Country report from Turkmenistan

Country report from Uzbekistan

Report of the Asian G-WADI secretariat

Visibility of Asian G-WADI (web site, brochure)

Brief presentation by Bhanu on the role of G-WADI pilot basins and their mechanism of cooperation

Future joint activities/ training activities of pilot basins (direction, implementation, communication, secretariat support, etc)

Funding and funding mechanisms

Programme coordination and Asian G-WADI secretariat

Next meeting other business

Close ceremony

## Appendix 2

### 2nd Asian G-WADI Meeting – Declaration Adopted

In Lanzhou/China, 28 representatives of the Asian G-WADI members from Ten Asian member countries (Afghanistan, China, India, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, and Uzbekistan), as well as representatives of UNESCO Offices (Beijing/New Delhi/Tehran), some members of the Steering Committee of the Global G-WADI Programme and few observers from other regions of the world met, presented country reports and discussed various issues related to the Asian G-WADI Network.

Resulting from an intensive and interactive process, the participants:

1. **Extended** special thanks and appreciation to our host "CAREERI", Prof Li Xin and his team, Imperial College of London, particularly Prof Howard Wheeler and his team and UNESCO Offices in Almaty/Beijing/New Delhi/Tehran, for the great opportunity provided to us to benefit from the Global Workshop in Groundwater Modeling and to hold a meeting of the Asian G-WADI Network;

2. **Underlined** the urgent need for Asian G-WADI Steering Committee Members and UNESCO Offices in the region to draw-up an updated version of the Terms of Reference for the Asian G-WADI coordination mechanism;

3. **Declared** their firm intention to work together to enhance the visibility and outreach of the Asian G-WADI network through a better coordinated web site and regularly updated information brochure;

4. **Committed** themselves as members of the Asian G-WADI to convince their governments and policy makers to prioritize water resources of the arid and semi arid regions of their countries. This will include contacting their planners and policy makers to secure funding from government budgets and other bilateral funding sources for pilot basins and other activities and providing successes in this direction to the G-WADI Asian secretariat and UNESCO;

5. **Called upon** UNESCO and the Global G-WADI network (whenever possible) to allocate sufficient seed resources to assist the Asian G-WADI Network to generate additional resources for their activities;

6. **Elected** CAREERI, P. R. China to take up immediately the responsibility to host the regional network secretariat for the next three years as agreed in the 2005 Asian G-WADI meeting on the rotation of the network secretariat;

7. **Agreed** that an Asian G-WADI Steering Committee be formed from Dr Forood Sharifi from Iran representing the Tehran Cluster, Dr Shakeel Ahmad from India representing the New Delhi Cluster and Dr Anatoly Kholmatov from the International Fund for Saving the Aral Sea representing the Almaty Cluster to assist the secretariat in the planning and the implementation of activities at the Regional level of Asia for three years;

8. **Requested** UNESCO Cluster Offices in Asia to assist the Asian G-WADI network to prepare in coordination with the Asian G-WADI secretariat (CAREERI) and the elected steering

committee, a plan of action identifying funding options;

9. **Agreed** that the previous coordinator of the Asian G-WADI Secretariat (NIH, India) would be an ex-official member of the Asian Steering Committee;

10. **Requested** the Asian G-WADI secretariat to coordinate and keep record of the activities of the network, including pilot basins, and come up with best practice(s) on the topics underlined by the Asian G-WADI network and regularly disseminate this information to all members of the network;

11. **Requested** the UNESCO-IHP Secretariat to include the current coordinator of the Asian G-WADI Network in the membership of the Steering Committee of the Global G-WADI Network.

**CAREERI, Lanzhou, P.R. China**  
**16 June 2007**

## Appendix 3

### Participants of G-WADI Lanzhou 2007

Abdo, Gamal , Sudan, University of Khartoum  
Aghayi, Mohammad-Mahdi , Iran, Mahab Ghodss Consulting Engineers  
Ahmed, Shakeel , India, National Geophysical Research Institute  
Alghazi, Khalid Abdulrahman M, Kingdom of Saudi Arabia, Arriyadh Development Authority  
Alizadeh, Amin , Iran, Ferdowsi University of Mashhad  
Bill Hu, USA, Florida State University  
Butler, P. Adrian , British, Imperial College London  
Carrera, Jesus , Spain, Earth Sciences Institute Jaume Almera  
Checheibaev, Amanbek , Kyrgyz, Central Asian Institute of Geosciences  
Dou, Yan, China, Xinjiang Institute of Ecology and Geography, CAS  
Edmunds, M. Wyndham , British, Oxford University Centre for the Environment  
Eqrar, N. Mohammad , Afghanistan, University of Kabul  
Gangas, M. Ana , Chile, National Water Agency  
Gendvaa, Udvaltsetseg , Mongolia, Academy of Science, Ministry of Science, Education and Culture, Mongolia  
Guan, Huade , Australia, Flinders University  
Hu, Hongchang , China, Lanzhou University  
Huang, Yue , China, Xinjiang Institute of Ecology and Geography, CAS  
Huang, Tianming , China, Institute of Geology and Geophysics, Chinese Academy of Sciences, CAS  
Janparvar, Mahdi , Iran, Toossab Consulting Firm  
Jayakumar, R. , India, UNESCO Beijing Cluster Office  
Katjimune, G.V.B. Mathews , Namibia, Ministry of Agriculture, Water and Forestry  
Kazakov, Mavlon , Tajikistan, Odessa Hydrometeorology Institute  
Khasankhanova, Gulchekhra , Uzbekstan, Ministry of Agriculture and Water Resources  
Khiabani, Hamid , Iran, Toossab Consulting Firm  
Kinzelbach, Wolfgang , Switzerland, Swiss Federal Institute of Technology  
Larabi, Abdelkader, Morocco, Mohammed V University of Rabat  
Li, Xin , China, Cold and Arid Region Environmental and Engineering Research Institute, CAS  
Litvak, Rafael , Kyrgyz, Kyrgyz Research Institute of Irrigation  
Mathias, A. Simon , British, Imperial College London  
Mohamed, Elfatih Mukhtar Mohammed , Sudan, Arriyadh Development Authority  
Najaf, I. Mohammad , Afghanistan, Kabul Polytechnic University  
Nan, Zhuotong , China, Cold and Arid Regions Environmental and Engineering Research Institute, CAS  
Nemer, Buyankhishig , Mongolia, Mongolian University of Science and Technology  
Neupane, Bhanu , India, UNESCO New Delhi Cluster Office  
Normatov, Inom , Tajikistan, Institute of Water problems, Hydropower and Ecology  
Polatbekov, Arman , Kazakstan, Research Institute of Hydrogeology and Hydrophysics  
Pulatov, Alim , Uzbekstan, International Department, ECOGIS Centre, Tashkent Institute of Irrigation

and Melioration

Raouf-Sheibani, Farhad , Iran, Toossab Consulting Firm

Rebolledo, Mario, Mexico, Centre for the Studies on Water, City

Rihani, Jehan , Jordan, University of California

Sadeghi, Niloofar , Iran, UNESCO Tehran Cluster Office

Salih, Abdin , Sudan, UNESCO Tehran Cluster Office

Satpayev, Gabdolgani , Kazakstan, Kazakhstan IHP Committee

Shah, A. Amjad , Pakistan, Water Resources Planning Development & Monitoring Directorate (WRPD&M), Government of Balochistan

Sharma, Anupma , India, Groundwater Hydrology Division, National Institute of Hydrology

Sharifi, Forood , Iran, Ministry of Jihad-e Agriculture

Sheikh, A. Ashfaq , Pakistan, Pakistan Council of Research in Water Resources

Shirzad, Siamak , Iran, Ministry of Energy

Simmons, Craig T. , Australia, Flinders University

Tynybekov, Azamat , Kyrgyz, Kyrgyz Russia Slavic University

Wang, Xusheng , China, China University of Geosciences

Wheater, S. Howard , British, Imperial College London

Xu, Xuexuan , China, Northwest Agriculture & Forestry University

Zhou, Jian , China, Cold and Arid Regions Environmental and Engineering Research Institute, CAS

Zhao, Jing , China, China University of Geosciences

Abbasgholipour Kazem, Iran, Mahab Ghodss Consulting Engineers

(total 56)

## Participants of 2<sup>nd</sup> G-WADI Asian meeting

Abbasgholipour, Kazem, Iran, Mahab Ghodss Consulting Engineers Co.

Abdo, Gamal , Sudan, University of Khartoum

Aghayi, Mohammad-Mahdi , Iran, Mahab Ghodss Consulting Engineers Co.Tehran

Ahmed, Shakeel , India, National Geophysical Research Institute, Hyderabad

Checheibaev, Amanbek , Kyrgyz, Central Asian Institute of Applied Geosciences

Eqrar, N. Mohammad , Afghanistan, University of Kabul, Faculty of Geoscience, Head of Geology Department

Gendvaa, Udvaltsetseg , Mongolia, Academy of Science, Ministry of Science, Education and Culture, Mongolia

Hu, Bill , USA, Florida State University

Janparvar, Mahdi , Iran, Toossab Consulting Firm

Jayakumar, R. , India, UNESCO Beijing Cluster Office

Kazakov, Mavlon , Tajikistan, Executive Committee of the International Found for saving the Aral Sea

Khasankhanova, Gulchekhra , Uzbekstan, Ministry of Agriculture and Water Resources

Khiabani, Hamid , Iran, Toossab Consulting Firm

Larabi, Abdelkader, Morocco, EMI- Rabat - Morocco

Li, Xin , China, Cold and Arid Region Environmental and Engineering Research Institute, CAS

Mathias, A. Simon , British, Imperial College London  
Najaf, I. Mohammad , Afghanistan, Kabul Polytecnic University  
Nan, Zhuotong , China, Cold and Arid Regions Environmental and Engineering Research Institute, CAS  
Nemer, Buyankhishig , Mongolia, Mongolian University of Science and Technology, Department of Hydroecology and Geoecology  
Neupane, Bhanu , India, UNESCO New Delhi Cluster Office  
Normatov, Inom , Tajikistan, Institute of Water problems, Hydropower and Ecology Academy of Sciences  
Raouf-Sheibani, Farhad , Iran, Toossab Consulting Firm  
Rihani, Jehan , Jordan, University of California (USA)  
Sadeghi, Niloofer , Iran, UNESCO Tehran Cluster Office  
Salih, Abdin , Sudan, UNESCO Tehran Cluster Office  
Satpayev, Gabdolgani , Kazakstan, “GEORID” Ltd. Kazakhstan  
Shah, A. Amjad , Pakistan, Water Resources Planning Development & Monitoring Directorate (WRPD&M), Government of Balochistan  
Sharma, Anupma , India, Groundwater Hydrology Division, National Institute of Hydrology  
Sheikh, A. Ashfaq , Pakistan, Pakistan Council of Research in Water Resources, M/O Science and Technology  
Shirzad, Siamak , Iran, Ministry of Energy  
Wheater, S. Howard , British, Imperial College London  
Xu, Xuexuan , China, Northwest Agriculture & Forestry University/ Institute of soil and water conservation, CAS  
Zhou, Jian , China, Cold and Arid Regions Environmental and Engineering Research Institute, CAS  
(total 33)