

Some reflections on the role of scientific organisations such as the International Association of Hydrogeologists (IAH) on education, professional development and advocacy

Kilka refleksji nad rolą organizacji naukowych, takich jak Międzynarodowe Stowarzyszenie Hydrogeologów (IAH), w edukacji, profesjonalnym rozwoju i rzecznictwie

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Abstract: A scientific association like the International Association of Hydrogeologists (IAH) can make a valuable contribution to education and life-long learning through activities such as conferences, publications and mentoring of early career professionals. There is also an important role to play in promoting a greater awareness of groundwater issues amongst all relevant stakeholders in sustainable water development, from individual consumers to policy makers. Recently the IAH has produced a series of Strategic Overview papers which aim to explain linkages between groundwater and other disciplines including human health, resilient cities and energy. Two of the topics covered by these papers are discussed in more detail: global change and the role of groundwater in the Sustainable Development Goals. To be successful advocates, all hydrogeologists need to be able to communicate effectively with the different stakeholders, using new tools, including as social media, where appropriate.

Streszczenie: Stowarzyszenie naukowe, takie jak Międzynarodowe Stowarzyszenie Hydrogeologów (IAH), może wnieść cenny wkład w kształcenie i uczenie się przez całe życie poprzez takie działania, jak konferencje, publikacje i mentoring profesjonalistów na wczesnym etapie kariery zawodowej. Istotną rolę odgrywa również promowanie wśród wszystkich zainteresowanych stron (od indywidualnych konsumentów po decydentów) większej świadomości kwestii związanych z wodami podziemnymi i ich znaczeniem dla zrównoważonego rozwoju. Ostatnio IAH opracowało serię artykułów pod tytułem: Strategic Overview Series (IAH-SOS). Do tej pory powstało siedem tego typu artykułów: Bezpieczeństwo żywnościowe i wody gruntowe, Sektor energetyczny i wody gruntowe, Rozwijające się miasta i wody podziemne, Ochrona ekosystemu i wody gruntowe, Zdrowie ludzkie i wody gruntowe, Globalne zmiany i woda gruntowa, ONZ-owskie cele zrównoważonego rozwoju do 2030 roku: podstawowe wskaźniki dla wód gruntowych. Artykuły te mają na celu wyjaśnienie powiązań między wodami podziemnymi i innymi dziedzinami, w tym ludzkim zdrowiem, rozwojem miast i energią. Omówiono bardziej szczegółowo dwa tematy poruszane w tych artykułach: zmiany globalne i rolę wód podziemnych w osiągnięciu celów zrównoważonego rozwoju. Aby odnieść sukces, wszyscy hydrogeolodzy muszą być w stanie skutecznie komunikować się z różnymi interesariuszami, wykorzystując nowe narzędzia, w tym (w stosownych przypadkach) media społecznościowe. Artykuł jest częściowo oparty na wystąpieniu wygłoszonym przez autora w październiku 2017 r. w Stellenbosch (RPA) podczas odbywającej się co dwa lata konferencji „Podziemna woda w RPA”.

Key words: Hydrogeology education, IAH, continuous professional development, groundwater global change

Słowa kluczowe: edukacji hydrogeologiczna, IAH, ciągły rozwój zawodowy, wody podziemne

INTRODUCTION

The International Association of Hydrogeologists (IAH) celebrated its 60th anniversary recently (in 2016) and it is timely to reflect on the role this organisation in the education and training of hydrogeologists, and in the

promotion of groundwater science more generally. Whilst the main focus of this paper is on education, lifelong learning activities and advocacy, it may be helpful to start with an overview of the wider role of the Association.

The mission of IAH is to “further the understanding, wise use and protection of groundwater resources throughout the world” (www.iah.org). To achieve this, the activities of the association include hosting scientific meetings, publishing an international journal and two book series, projects, and establishing a series of Com-

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missions and Networks which focus on specific scientific themes and topics. The association has a central secretariat (based in UK), but many of its activities are organised at a country level through a series of National Chapters (including a very active chapter in Poland).

Many of the National Chapters of IAH organise conferences of national or regional interest, and these make an important contribution to local networking and sharing of scientific research. In addition there is a major international congress each year (the 2010 congress was in Krakow) which brings together hydrogeologists from across the world, and facilitates meetings of Commissions and Networks, and the holding of the Association's General Assembly (which has to be held annually).

One of the most important scientific activities of the association is the publication of *Hydrogeology Journal*. For a specialist journal this now has a relatively high impact factor (of over 2) and publishes about 140 articles per year; importantly, it has a high usage, as indicated by the large number of downloads (220,000 article downloads in 2016). IAH also publishes two book series (through CRC Press in the Netherlands, part of the Taylor & Francis Group), the so-called Green books that generally comprise selected papers from conferences and congresses, and the Blue books – the International Contributions to Hydrogeology – that may consist of a monograph on a particular hydrogeology topic or a collection of papers on a theme of broad international interest.

IAH project activities have included the UN Global Environmental Facility (GEF) “Groundwater Governance – A Global Framework for Action” (in collaboration with UNESCO and FAO – see (FAO 2016)); the WHYMAP (the World-wide Hydrogeological Mapping and Assessment Programme), which was coordinated by UNESCO and involved the German Geological Survey (BGR 2016); and the World Karst Aquifer Mapping (WOKAM) project (IAH Karst Commission, funded by IAH), the concepts behind which are described in (Chen et al. 2017).

Many of the Association's scientific activities are coordinated by a series of Commissions and Networks. These currently relate to topics such as karst hydrogeology (The Commission for which oversaw the production of the karst aquifer map referred to above), managed aqu-

ifer recharge, urban groundwater, climate change, groundwater and international development, transboundary aquifers, regional groundwater flow, and fractured rock hydrogeology. There is also an Early Careers Hydrogeologists' Network, which provides a forum for hydrogeologists at the beginning of their careers.

Following this overview of IAH, the remainder of this paper will focus on educational activities including mentoring, the preparation of strategic overview papers on key topics at the interface between groundwater and other disciplines – with global change and the Sustainable Development Goals described as examples – and advocacy, especially the challenge of trying to get our message across to other stakeholders, including the general public and policy makers.

EDUCATION

It is essential that the fundamental principles of hydrogeology are taught during a primary and/or postgraduate university degree because it is difficult for a hydrogeologist to catch up on this core material later in their careers (Misstear 2016). Nevertheless, a university course is only part of the required education and training for a professional hydrogeologist, and scientific associations like the IAH also perform an important role in career development. One example is through the introduction of a mentoring scheme for early career professionals.

Mentoring

The aims of the IAH mentoring scheme (quoting from the IAH website) are to help members in the following:

- a) the science – providing advice and technical knowledge on various topics within the many strands of hydrogeological science;
- b) career options and pathways – providing guidance on job types and locations, CVs, interviews, networking, courses and training openings;
- c) practical experience – case studies, local hydrogeological knowledge of specific regions or aquifer types, volunteering to undertake short assignments.

The scheme is still at a relatively early stage, and will need to be monitored and evaluated carefully to ensure that it fulfils the expectations of both the mentees and the mentors.

Publications

Hydrogeology Journal and the other publications of IAH have an educational as well as a scientific purpose. In relation to the journal, this role was enhanced with the introduction in 2013 of a new type of review paper called Foundations. The aim of this type of paper is to allow authors to review some of the basic principles of hydrogeological science in a depth that is beyond that possible in most textbooks (Post 2013). Excellent recent examples include the two papers on the hydraulics of water wells published by Houben in 2015.

A Review of IAH's Educational Priorities

Some of the education and training priorities for IAH were highlighted in a report prepared by a Working Group on Groundwater (IAH 2014):

- a) preparing a list of hydrogeology degree courses available internationally, with links to course information from the IAH Education web pages;
- b) listing short-courses, field courses and webinars organized by national chapters on the IAH Education webpages;
- c) developing an IAH YouTube channel or equivalent;
- d) linking in with existing webinar providers to provide IAH-branded talks.
- e) compiling an international panel of experts who would potentially be willing to contribute to short courses organized and run by national chapters;
- f) preparing IAH-branded educational materials (lectures, illustrations, etc) and making these available for download from the website;
- g) developing short thematic papers on key strategic topics to help IAH increase the awareness of groundwater issues amongst policy makers and water managers, and with the wider public.

Several of these actions have been implemented or are underway. For example, training courses are now included on the Association's home page and a listing of hydrogeology degree courses is in progress. Moreover, the website is being upgraded to include several pages dedicated to education, with pages aimed at the general public as well as pages geared towards groundwater professionals.

STRATEGIC OVERVIEW TOPICS

Since the preparation of the review report, one of the major actions has been the preparation of a series of thematic papers [item (g) in the above list] to inform professionals in other sectors about the interactions between those sectors and groundwater (IAH 2015; 2016; 2017). These are referred to as Strategic Overview papers, and seven papers have been produced to date:

- a) Food Security & Groundwater.
- b) The Energy Sector & Groundwater.
- c) Resilient Cities & Groundwater.
- d) Ecosystem Conservation & Groundwater.
- e) Human Health & Groundwater.
- f) Global Change & Groundwater.
- g) The UN SDGs for 2030: Essential Indicators for Groundwater.

The papers are available on the IAH website (https://iah.org/knowledge/strategic_overview_series) and an article about the series has been published in *Geoscientist* (Foster, Chilton 2016). Here, we will consider some of the issues surrounding the last two papers, relating to global change (involving climate and land use change) and the Sustainable Development Goals.

Global change

The Strategic Overview paper *Global Change & Groundwater* considers the impacts of both climate change and land use change. Aquifers, which often have large storage capacities and long residence times, potentially offer considerable resilience to some of the impacts of climate change. However, the potential impacts are complex and, until fairly recently, have received much less attention in the scientific literature than impacts on surface water. In the last decade there has been an increasing focus on the importance of trying to understand climate impacts on groundwater. (A useful review paper was published in *Nature Geoscience* by Taylor et al. in 2013). Nevertheless, much remains to be done to understand the impacts of changing precipitation intensities and temperatures on recharge rates. It is also important to recognise that some of the world's largest groundwater reserves are found in arid regions, within aquifers that receive little or no modern recharge, and where a greater understanding of the long-term effects of groundwater withdrawals is required.

An interesting current project involving the Association's Early Careers Hydrogeologists' Network (ECHN-IAH) with the UNESCO International Hydrological Programme (IHP), aims to engage the next generation of water leaders in the debate over groundwater and climate change. The project recognises the need for greater outreach, networking, training courses and international collaboration on this topic. The work is being carried out under the Groundwater Resources Assessment under the Pressures of Humanity and Climate Change (GRAPHIC) project, and includes free access (time-limited) to a number of papers on climate change research (Re et al. 2018).

As well as changing climate, the consequences of changes in land use, especially impacts arising from intensification of agriculture and increased urbanisation, are also important (these issues are also addressed in other papers in the IAH Strategic Overview series, including those on Food Security & Groundwater (IAH 2015), and Resilient Cities & Groundwater (IAH 2016)). As noted in the paper on Global Change & Groundwater, it is striking that more than half of the inhabitable land on our planet has been modified by human activity over the past 250 years – mainly through cutting down forest and replacing it with arable agriculture and pasture. The extent of intensification is illustrated by the fact that whereas food production has increased three-fold since 1960, the area of land under agriculture has increased by only 10%. This intensification of agriculture can have major impacts on both groundwater recharge (from irrigation return flows) and water quality (land salinization, and increased fertiliser and pesticide usage). Whereas climate change receives a lot of media attention, there is perhaps less debate about the impacts of population growth and land use change.

Groundwater and the SDGs

The IAH Strategic Overview paper on the UN-SDGs for 2030 points out that, although groundwater is a key resource for achieving the SDGs, it is “still weakly conceptualised in the SDG indicators” (IAH 2017).

The IAH Strategic Overview paper includes some key messages and identifies a number of priority actions in connection with the SDG targets, indicators and data collection. For example, when assessing progress in rela-

tion to Target 6.1 (universal and affordable access to safe drinking water quality), it will be necessary to have proper appraisals of the design, construction, reliable yield and integrity of wells and boreholes, since these are critical factors in achieving an adequate and sustainable water supply (Misstear et al. 2017). For SDG Target 6.4 (management and reduction of water stress), it is recommended that SDG indicators should be included stating that “halting the long-term depletion of groundwater systems is a central activity for dealing with global water stress”. For Target 6.6 (restoring and protecting water-related ecosystems), it is necessary to have clarity as to whether this includes a requirement for “protecting aquifers generally as aquatic ecosystems or only where they are directly associated with dependent ecosystems”.

Monitoring proposals in relation to the SDGs have focused on parameters more relevant to surface waters than groundwaters e.g. dissolved oxygen and phosphorus. The IAH Strategic Overview paper identifies basic and supplementary parameters suitable for monitoring groundwater. It also highlights many of the complexities surrounding the monitoring of groundwater systems, owing to aquifer heterogeneity, long residence times (which can mask changes in recharge water quality), the effects of the design and construction of the monitoring boreholes, and the impacts of local pollution sources on the data. All of these tasks will require hydrogeological expertise, as will the interpretation of the data, thus providing opportunities for hydrogeologists to play a major part in the monitoring and evaluation programmes.

ADVOCACY: COMMUNICATING THE MESSAGE

Whilst it is obviously important that hydrogeologists debate among themselves key issues such as the role of groundwater in achieving the SDGs, a greater challenge is for hydrogeologists to try to get their messages across to all the relevant stakeholders, from individual farmers to Government ministers. To promote integrated water resources management, for example, which is a key principle in many international and national policies - and is mentioned in SDG Target 6.5 – this needs to be tackled at all levels. To engage farmers and individual well owners, a bottom up approach is necessary (Boyden 2015). Daly (2017) argues that we need to get out of our own “silos” and connect with other disciplines in order to strive to-

wards integrated catchment management.

Traditional communication approaches, including face-to-face-meetings, will continue to be important at all levels (and at the best times to influence decisions, whether this is with the farmer prior to the main fertiliser application period, or the politician who is preparing a policy paper), or writing and presenting strategy documents using language that is appropriate for the intended audience. We can also make increasing use of newer communication tools including social media. Re and Misstear (2018) discuss some of the pros and cons of increased usage of social media for promoting integrated water resources management.

Collaborative research across various disciplines can also help in improving our awareness of other viewpoints, and hence for getting out of our siloes. One example is the recently completed research project in Uganda called Water is Life: Amazzi Bulamu (Fagan et al. 2015). This project was funded by Irish Aid and the Higher Education Authority, and involved several third-level institutions in Ireland as well as Makerere University in Kampala, plus a number of Non-Governmental Organisations (NGOs). The novel aspect of the research was its holistic approach. Several PhD projects were carried out in a small area (Makondo parish in Lwengo District), with themes ranging from social sciences (gender issues and conflict) to hydrogeology and engineering (impacts of climate change on well supplies, and solar disinfection of harvested rainwater). The individual researchers certainly learnt a lot about other disciplines, and hopefully this will influence their future teaching on water development in Africa. Engagement with the local community was a high priority of the research programme, both in terms of the data collection and also for the dissemination of the research findings. A 30-minute video describing the project is available on YouTube: <https://www.youtube.com/watch?v=6pzXXRG3ihM>.

CONCLUSIONS

The hydrogeological community clearly faces considerable challenges in the coming years when tackling global issues such as adapting to global change and meeting the SDG targets. This paper has described how a scientific organisation such as IAH can play a major role in the training and professional development of

hydrogeologists – and in advocating messages about responsible groundwater management to other parties, including water engineers, policy makers, politicians and the general public. This latter aspect is possibly the key challenge for us, but one which provides hydrogeologists with an opportunity to exert the level of influence on sustainable development that our precious groundwater resource warrants.

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