

Yuan Daoxian: an interview with a distinguished hydrogeologist from China

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Introduction

The world is very concerned about the huge environmental problems in China. Yuan Daoxian (born in 1933) is one of the leading scientists working on the investigation and resolution of these problems, with a particular focus on the karst regions of southwest China, which are home to more than 100 million people. Soil erosion and rock desertification affect an estimated 100,000 km², but groundwater contamination and local or temporal water shortages are also key problems to be addressed. Yuan Daoxian is arguably the most experienced karst and hydrogeology researcher in China; he is a great teacher to the younger generation, and a great communicator who has opened Chinese karst and environmental research to the world. Among karst hydrogeologists, Yuan Daoxian is internationally known. His early books and papers were written in Chinese and are consequently largely unknown to the international community, but represent standard references in China.

During the workshop *Current Technology in Karst Hydrogeology and Water Resources* that took place at the Southwest University of China in Beibei, Chongqing, 7–14 October 2007, the authors had the opportunity to talk

with Yuan Daoxian about his life and his research (Fig. 1). The transcript of the interview and a map of the locations mentioned are available as Electronic Supplementary Material and the interview itself can be seen on the Hydrogeologist Time Capsule website (<http://timecapsule.iah.org>). This profile highlights several stations of his life and summarises his main scientific achievements, which can only be fully appreciated in relation to the recent history of China and the present environmental problems in this emerging economic power.

First professional experiences with karst hydrogeology

Yuan Daoxian graduated from the College of Geology in Nanjing in 1952 and had his first professional experiences as the deputy chief of an engineering and geological team on a dam site on the Yellow River, before he went to Tibet for three years in the mid 1950s. As the head of a small team of geologists there, he built a hydropower station for the electricity supply of the Potala Palace in Lhasa. In order to make a survey of the hydropower resources of the Yarlung Tsangpo River, he and his team walked along the river for about three months. In the interview, he told us how he was impressed by the natural environment in Tibet, but shocked by the harsh living conditions and the agricultural slave system.

When Yuan Daoxian returned from Tibet in 1957, he was asked to stay in the Ministry of Geology in Beijing and to do office work, but he preferred fieldwork. The project that became his first professional contact with karst was related to the siting of dams for hydropower along a large tributary of the Yangtze River: “I was very impressed by the karst along Wujiang River. There are a lot of gorges and big karst springs along the river. The concern was that underground streams around dam sites might lead to serious leakage problems. So we did a lot of survey of karstic features, such as dolines, caves, springs and so on, to make feasible selection of dam sites and hydropower stations. This was the first time I was quite involved in karst research. It took us three months

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Fig. 1 Yuan Daoxian during the Karst Hydrogeology Workshop in October 2007, explaining the geology of the Qing Muguan karst test site near Chongqing, where he also lived as a schoolboy (photo: N. Goldscheider)

walking in the karst region, 20 km per day, with poor conditions, no highway, no hotel; we lived in farmers' houses. We were a comprehensive team composed of seven people in all, (experienced in) hydro-engineering, geology, navigation."

Afterward, he was appointed the chief of a hydro-geological team in Shandong Province, a region with a lot of karst, where he investigated groundwater resources, drilled boreholes and helped to solve water shortage problems.

From the cultural revolution to his first hydrogeology textbook

During the Cultural Revolution, which officially lasted from 1966 to 1969 but only actually ended in 1976, many intellectuals and academics were removed from their positions to work as farmers on the countryside. When we talked with Yuan Daoxian about this time, he said, "I was lucky, I was just asked to go to the rural area to help people to find water". So again, he moved from administrative work to more practical work. This included hydrogeological investigations and challenging caving in order to find underground streams that could be exploited as drinking water sources for the local people.

"I tried to collect methods from experiences of local people to find water. For example, they told us how to identify fish species, and about the relationship between the quantity of fish and cavities in the underground. Because they also fed their cattle in karst mountains, they had much knowledge on which entrance had more possible connections with underground streams. I learned a lot from the farmers. I collected this knowledge and

wrote a book summarising all the experiences of the farmers, together with some technologies that the farmers did not know."

Karst Hydrogeology for Water Supply, Yuan Daoxian's first textbook, was published in 1979 and is highly read in schools, universities, and geological bureaus in karst regions of China as a handbook, but is now out of print (Yuan 1979).

The opening of China and the step to international karst research

When Deng Xiaoping took leadership in 1979, China started to open to the world. Yuan Daoxian was among the first who contributed to this opening in the field of karst and hydrogeology. Shortly before this he was appointed director of the newly established Institute of Karst Geology in Guilin, situated in the middle of a world-famous tower-karst landscape. His first trip outside of China was to France in 1981. There he met Henri Paloc, president of the IAH Karst Commission, and William Back from the US Geological Survey. They visited French karst aquifer systems and experimental sites and Yuan Daoxian became the first Chinese member of the Karst Commission. This was also the starting point of intense and manifold exchange between Chinese and American karst researchers. During a conference of the American Association for the Advancement of Science in 1983 in Detroit, Yuan Daoxian gave a keynote lecture in which he drew the attention of the scientific community to the environmental and hydrogeological problems in China. Afterwards William Back took him on a long expedition to many important karst regions of the US, such as Mammoth Cave in Kentucky.

This 'scientific opening policy' also resulted in several books: *Glossary of Karst Geology* (Yuan 1988a, Chinese with English indices); *The Science of Karst Environment* (Yuan 1988b), which was written in Chinese but considers international concepts; and the first international textbook on the *Karst of China* (Yuan 1991). His international journal articles also focus on environmental problems in karst regions (Yuan 1988c) or present results from hydrogeological experimental sites near Guilin (Yuan et al. 1990).

Another significant outcome of his indefatigable efforts to foster exchange between China and the rest of the world is the organisation of the 21st IAH Congress, which took place in 1988 in Guilin. More than 500 people attended this congress and participated in several excursions.

International hydrogeological, ecological and climate change research

In continuation of his international scientific coordination efforts, Yuan Daoxian headed or co-headed four projects

within the International Geoscience Programme (formerly International Geological Correlation Programme) (IGCP) of UNESCO:

- IGCP 299: Geology, climate, hydrology and karst formation (1990–1994)
- IGCP 379: Karst processes and the carbon cycle (1995–1999)
- IGCP 448: World correlation of karst ecosystems (2000–2004)
- IGCP 513: Global study of karst aquifers and water resources (since 2005)

It is noteworthy that these projects focus on topics that were only recently fully recognised as important issues by the hydrogeology community such as the relationship between groundwater environments and climate change, and an ecosystems approach to hydrogeology. This cooperation framework, along with national research grants, resulted in major scientific insights such as the reconstruction of the Last Interglacial Asian monsoon by means of absolute dating and oxygen isotope ratios, published in *Science* (Yuan et al. 2004).

Other relevant publications include a general conceptualisation of the karst dynamics system and its role within the global carbon cycle (Yuan 1997); a holistic appreciation of the karst ecosystem (Yuan 2001); new insights into the relationship between the hydrological and geological environment and human health in China (Yuan 2002); and joint publications with American colleagues about karst aquifer storm-scale hydrochemistry (Liu et al. 2004).

Working on the resolutions of China's environmental problems

The research described in the last section also prepared ground for the “China Environmental Health Project”, coordinated by Chris Groves from Western Kentucky University and supported by the US Agency for International Development (USAID) since 2007. The project aims to improve the living conditions of the population in southwest Chinese karst regions by improving access to safe drinking water and protecting the environmental integrity of valuable karst groundwater resources.

“Karst problems are very complicated. In my understanding about karst aquifers, the most important aspect is heterogeneity. The problem has not been solved yet: How to estimate, how to exploit karst water resources and how to avoid pollution? The 3,000 underground streams of southwest China need to be protected, because the situation is getting worse. That is why I gave a special report to the State Council to call our attention on how to protect them. However, solving such problems is not easy. It needs scientific knowledge and encouraging the local people's participation, and education.”

Other environmental problems, on which Yuan Daoxian and his research teams in Guilin and Chongqing are working, include soil erosion and rock desertification, and the identification of better land-use practices that can stop or prevent this largely irreversible process. They are researching the cultivation of plants that are economically beneficial but do not require the soil to be ploughed, including medicinal herbs and woody plants. This goes along with fundamental research on soil ecology and microbiology (e.g. Li et al. 2005).

Yuan Daoxian explained that he considers research, education, and international cooperation keys to solving the serious environmental problems of China, a conviction he passes along to his students: “At present, I think my important job is to train the young people, to transfer the platform to the younger generation.” And everyone who has experienced the spirit at the institutes in Chongqing and Guilin feels that his students are on a good path.

A recent success of his efforts is the creation of a new International Research Center of Karst (IRCK) under the Auspices of UNESCO, which will be established in Guilin in 2008. The focus of this institute will be on hydrogeology; so much more exchange between Chinese and international karst hydrogeologists can be expected in the near future.

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