Role and Importance of Geoscience to Environmental Management and Sustainable Development

Dhia Al Bakri, University of Sydney, Orange NSW, Australia

Introduction

As geoscience education has traditionally focused on exploration and exploitation of minerals and energy, geoscientists have been unable to contribute meaningfully and significantly to other societal concerns such as environmental management and sustainable development (EMSD). This inability has seriously limited the growth and development of the profession and marginalised its role in relation to many relevant issues that are of particular interest to modern societies. It is remarkable that geoscience has been largely overlooked in the environmental and sustainability debate despite the fact that geology is the ultimate causal factor influencing the genesis and intrinsic properties of all natural resources such as soil, water, flora and fauna (Al Bakri 1998, Al Bakri 2000). By focussing on a relatively narrow geoscience education paradigm (production paradigm), the profession has contributed, inadvertently, to its exclusion from the vibrant and rapidly growing area of EMSD. As a result, the general public and, indeed, most geoscientists have developed a perception that geoscience is only relevant to the mining and energy industry.

This paper argues that traditional geoscience education has failed to attract a wide interest in the discipline and there is an urgent need to effect a paradigm shift by focusing on the importance of geoscience to EMSD. Such a paradigm shift is essential to reverse the trend of declining interest in the profession and to set the foundation for sustainable growth and development in geoscience education and employment.

Challenges to Geoscience

Given the narrow focus of geoscience education, geoscientists are mostly employed in the mining and petroleum industries and related research organisations, government agencies and consulting firms. Traditional geoscience (production paradigm) is currently facing profound challenges in terms of maintaining and developing a wide interest in the discipline. One of the most serious challenges is the recent decline in employment opportunities within the traditional mining and energy sector. For instance, the geoscience profession in Australia is currently facing a grave unemployment crisis. According to the Australian Institute of Geoscientists, the number of professional geoscientists in Australia declined from 8000 in 1996 to a mere 3500 in 1999 (AIG 1999a). This means that 56% of geoscientists have left the profession, over the past 4 years, due to lack of employment opportunities. Furthermore, the national rate of unemployment among the remaining geoscientists was 12.5% in late 1999 (AIG 1999b). This level is higher than the national rate of general unemployment which was 7% in the corresponding period. The unemployment problem is being compounded by a drop in university enrolments for geological sciences. Concern is at its highest regarding the long-term viability of some of the geology faculties in Australia (AIG 1999a).

Anecdotal evidence suggests that a similar pattern is emerging in many other countries. If traditional geoscience education remains the dominant paradigm, it is believed that this downturn in geoscience education and employment will worsen in the future for the following reasons:

- Low mineral commodity prices are causing significant downturns in exploration activity and mining
- Legislation of environmental protection and sustainable development is reducing access to geological resources
- Most geological resources have either been discovered or depleted
- Fossil fuels are likely to be replaced with renewable energy sources within this century
- Geoscientists lack the ability to transcend the traditional boundary of the discipline.

As a result of the above limitations, the long-term viability of the geoscience profession and its relevance to the wider community are becoming increasingly at risk. To overcome this challenge, we must seriously consider adopting a new educational paradigm to expand the scope of geoscience teaching in order to make the discipline more relevant to the aspirations of the wider community. The new educational paradigm should aim to produce graduates with considerable lateral thinking and an ability to deal with problems that transcend the traditional boundaries of the discipline.

Geology and EMSD: A Paradigm Shift

The area of environmental management and sustainable development (EMSD) presents a valuable opportunity to effect the desired

paradigm change in geoscience education. This paradigm shift will revitalise interest in the discipline, set the foundation for sustainable growth and development in geoscience education and employment, and provide a much needed geoscience input to EMSD. To date, there has been very little interest by geoscientists in EMSD because the role and value of geoscience to EMSD issues are grossly underestimated and poorly understood. Geology and related earth science processes play a paramount role in determining the inherent constraints, potential and resilience of any biophysical system. By studying geology, we should be able to develop genetic models that can explain, predict and diagnose the wide ranging issues related to EMSD. The author argues that sustainability is untenable without appropriate geological input (Al Bakri 1998, Al Bakri 2000). EMSD issues that critically require geological inputs but receive little or no attention from geoscientists are shown in Figure 1 and listed below:

1. Natural hazards and risk management
- Earthquakes
- Volcanic eruption
- Landslides and mass wasting
- Slope stability and subsidence
- Flood, erosion, sedimentation
- Landforming processes

2. Sustainable land management
- Soil properties and resilience
- Soil salinisation
- Soil sodicity & acidity
- Soil fertility
- Soil contamination
- Desertification and sand-dust storms

3. Sustainable water resource management
- Surface runoff and stream flow
- Groundwater contamination
- Watertable rise, salinisation & waterlogging
- Water quality and pollution
- Eutrophication & algal blooms
- Trace metal pollution
- Turbidity and suspended solid

4. Environmental planning and management
- Environmental impact assessment
- Land use planning and site selection
- Sustainable coastal management
- Sustainable catchment management
- Geoindicators for environmental management
- Ecotourism

5. Sustainable rural and agricultural development
- Sustainable rural development
- Sustainability & productivity of different agricultural systems
- Sustainable management and remediation of mineral and energy production sites
- Assessment of natural resources to sustain rural communities and infrastructure

6. Sustainable urban development
- Waste management and waste disposal
- Stormwater management
- Building and construction material
- Geotechnical investigations for urban infrastructure.

A number of papers have been published by the author and his co-researchers providing explanation and case studies to demonstrate the role and importance of geoscience to the above EMSD issues (Al Bakri 2000, Al Bakri *et al.* 1999, Al Bakri and Chowdhury 1999, Al Bakri 1998, Al Bakri *et al.* 1997 a & b, Al Bakri and Chowdhury 1997, Al Bakri 1996, Al Bakri 1994).

Conclusions and Recommendations

The reasons that geoscientists have not been fully engaged in EMSD to date are twofold. First, the role and importance of geoscience to address EMSD issues are not well understood or appreciated by most geoscientists, including university teaching staff. Consequently, environmental geoscience education has received limited attention in most geology faculties. Second, many of the existing publications and texts dealing with environmental geoscience tend to be limited in scope, do not establish the link between geoscience and EMSD, and do not explain how to employ geological principles and tools to address environmental and sustainability issues. To achieve the proposed paradigm shift in geoscience, it is recommended that:

1. Environmental geoscience should be made a central element of the tertiary educational curriculum.

2. Postgraduate courses and training in environmental geoscience should be offered by geology faculties.

3. Environmental geoscience education should adopt a problem-solving approach to

demonstrate the importance and application of geosience to EMSD.

4. Professional organisations and institutions concerned with geoscience should take initiatives to encourage research and publications that deal with the application of geoscience to EMSD.

5. Geoscientific bodies and institutions should organise conferences, workshops, and training courses for geoscientists, land managers and resource users to enhance their understanding and appreciation of geoscience application to EMSD.

6. A more concerted effort should be made to develop user friendly geological techniques and models for use in EMSD.

References

AIG 1999a. *Employment of geoscientists*, Australian Institute of Geoscientists web site http://www.aig.asn.au/explor_unemp.htm. December 1999.

AIG 1999b. *AIG News*, Quarterly Newsletter no. 58, November 199, Australian Institute of Geoscientists, Perth, Australia.

Al Bakri, D. 1996. A geomorphological approach to sustainable management of the coastal zone of Kuwait, *Geomorphology*, 18, 141-157.

Al Bakri, D. 1994. A geomorphic framework for developing a sustainable greening Programs in arid environment, *The Environmentalist*, 14, (3), 271 - 282.

Al Bakri, D. 1998. A geological approach to sustainable resource management, a paper presented at the *14th Australian Geological Convention*, 6-10 July 1998, Townsville, Queensland.

Al Bakri, D. 2000. Towards developing a geoscientific approach to sustainable agricultural rural development, *Journal of Environmental Geology* (submitted).

Al Bakri, D., Behbehani M. and Khuraibet, A., 1997b. Quantitative assessment of the intertidal environment of Kuwait II: Controlling factors, *Journal of Environmental Management*, 51, 333-341.

Al Bakri, D. and Chowdhury M. 1997. *Water Quality of Orange Water Supply Catchment*, report presented at the workshop on water quality in Orange, project no. CW0191.94, Orange, NSW, 58p.

Al Bakri, D. and Chowdhury, M. 1999. Nutrients and algal blooms: Lessons from inland catchments, chapter in *Preserving Rural Australia: Issues and solutions*, (eds: A. Robertson and R. Watts), CSIRO Publishing, Collingwood Vic, 60-68.

Al Bakri, D., Kuraibet, A. and Behbehani, M. 1997a. Quantitative assessment of the intertidal environment of Kuwait I: Integrated environmental classification, *Journal of Environmental Management*, 51, 321-332.

Al Bakri, D., Wickam, J. and Chowdhury, M. 1999. Biophysical demand and sustainable water resource management: An Australia perspective, *Hydrological Sciences Journal*, 44 (4), August.

Figure 1. Geoscience and environmental management and sustainable development.