RECENT TRENDS IN NORTH AMERICAN ENVIRONMENTAL GEOSCIENCES

SHLEMON, Roy J., P.O. Box 3066, Newport Beach, California 92659-0620, USA.

Summary

The last decade of budget cuts in Canada and the United States reduced environmental-geoscience research in academic and governmental agencies. However, recent improvements in the economy have ameliorated this problem, and the geosciences should be reasonably well funded into the next decade. Particular issues and trends in North America relate to governmental registration of professional environmental geoscientists, to opportunities for public and private-sector employment, to increasing concern with urban-induced erosion, and to "prediction" and mitigation of floods, seismic events, slope stability and subsidence. The term "geologic hazard" is now in vogue, for it presently provides public interest, financial support for research, and the growth of a "geologic-hazard industry." However, future "selling" of geologic hazards may ultimately diminish public perception of the environmental geologist as an unbiased scientist. Public policy and political decisions continue to direct specific topics and geographical areas for North American environmental-geoscience research and applications; and these will likely continue as we enter the 21st Century.

Introduction

Many technical and political issues still face the North American environmental geoscientist. Major floods, seismicity and slope-stability problems are always at the fore, owing to their dramatic impact on the landscape and to their increasing depiction on national television and on the Internet. Accordingly, many environmental geoscientists often appear on television as "unbiased" experts who describe the particular geologic or geotechnical issue, and offer advice about the need for increased research funding. Further, groundwater remediation continues relatively unabated. And many consulting environmental geoscientists are in demand as expert witnesses in litigation. The proliferation of environmental geoscientists now raises serious questions about professional competence, and hence the need for either national or at least local testing and registration.

Additionally, the term "environment" is increasingly used by all geoscience disciplines, mainly because of the opportunity to capture public interest and as well financial support from government. Therefore many technical journals now incorporate "environment" into their titles, but journal content essentially remains the same. However, the rise of the Internet opens up new avenues of technical communication, including dissemination of "real-time" data, such as seismographic and hydrologic recordings.

Urban-induced erosion, particularly that engendered by mass-grading housing projects in western North America, has now spawned new governmental regulation, and hence opportunities for environmental geoscientists. Increasing governmental regulation, both national and local, may well require full disclosure of potential active faults, slope stability problems, flood zones, contaminants and other "geologic hazards" before a property can be sold. Whether socially desirable or not, increasing governmental regulation – ostensibly to benefit public safety – provides financial benefits to the North American environmental-geoscience community; and these are likely to increase in the immediate future.

Professional Registration

North American geoscience research is often carried out by universities and governmental agencies. Academic qualifications are high, but usually no particular testing or license is required. However, many States now require that a practicing geoenvironmental or geotechnical consultant be licensed. Registration of physicians and engineers has long been normal. But now, ostensibly to protect the public, registration of geologists and other environmental specialists is becoming widespread. This is particularly well exemplified in California where examinations and experience are required to become a "Registered Geologist." But that is not all: we now have "Certified Engineering Geologists" and "Certified Hydrogeologists," individuals who have passed additional specialty examinations. Further, an entirely different State agency regulates and issues certificates of competency for "Registered Environmental Assessors." Whether one jurisdiction accepts the licensing of another is often in doubt. Such licensing chaos may ultimately give way to a national licensure based on testing and experience. Undoubtedly, each State will require additional written examinations to determine an applicant's competence to handle local environmental geoscience issues.

Environmental Journals and the Internet

The term "environment" is in vogue. Accordingly, several traditional engineering and geological journals have recently changed their names to reflect inclusion of environmental articles. For example, the venerable "Bulletin of the Association of Engineering Geologists" is now "Environmental and Engineering Geoscience." Additionally, the Internet has spawned numerous geoscience web sites. These increasingly are capturing the interest of the public as well as the practicing environmental geoscientist. This is particularly well exemplified by the U.S. Geological Survey and University sites that now provide "real-time" seismic and hydrologic data. We thus can now see, almost instantaneously, seismograms and photographs of earthquake ground rupture and damage from almost any place in the world.

Employment in the Environmental Geosciences

With the present generally low price of oil, there has been a substantial reduction in North American hydrocarbon exploration. Many former petroleum geologists have therefore sought employment in the environmental field, particularly in groundwater remediation. The general philosophy is "a fluid is a fluid." Often, retraining has been necessary, and a plethora of groundwater courses are now offered by universities and by professional organizations. But employment opportunities in groundwater remediation may be becoming more scarce owing to clean-up of many so-called "superfund sites." However, the need for more urban landfills, and the related environmental impacts these bring, still offers jobs to the well-qualified geoscientist.

Erosion Control

We commonly think of accelerated erosion as pertaining to agricultural practice. However, mass-grading for residential construction, and building of shopping and other commercial centers has spawned new environmental concerns; specifically, sediment production and uncontrolled runoff into sewage systems and ultimately into natural drainage. A new subfield is therefore developing for the environmental geoscientist: "erosion-control specialist." Some State or Provincial agencies, such as the California Department of Transportation, provide in-house training, necessarily focusing on erosion potential for highway and bridge construction. But private consultants are also finding employment opportunities. Many erosion control specialists are trained as civil engineers. However, geologists, particularly those with a good background in fluvial geomorphology, are also doing well. Some jurisdictions license, or at least recognize, soil scientists (pedologists) as similarly competent to design erosion-control systems (see, for example, the International Erosion Control Association: www.ieca.org).

Floods

Whether caused by "El Nino" events or by local climatic conditions, floods always cause extensive property damage and often loss of life. Recently, so-called 100-year floods (which ironically occur every 20 years or so) in the upper Mississippi River Basin, in the Central Valley of California, and along the East Coast of the United States, have raised serious questions about the adequacy of floodplain zoning. Levees are raised, new dams are built and, invariably, such increased expenditure of public funds for flood control accelerates urbanization and ultimately increases damage (Mount, 1995). Should government abandon the policy of subsidizing low-cost insurance for structures built in obvious river and coastal flood zones? Although well meaning, the policy tends to perpetuate flood-zone construction. The private-sector insurance industry is now attempting to cope with increasing flood-zone losses by issuing policies with deductibles up to about 10 percent of the value of a structure. For example, rather than buying a traditional $5,000 or $ 10,000, fixed-deductible policy, the owner of a valuable coastal property now has a choice: be prepared to pay several times that amount in the event of damage, or consider moving out of a high risk area.

Seismic Constraints

Moderate to occasional high-magnitude earthquakes are common in California. Thus over 20 years ago the State mandated that its geological agency "zone" all known active (Holocene) faults. The purpose of the zoning was essentially two-fold: to ensure that the public is aware of local seismic potential, and to deter construction of habitable structures across a fault with ground-rupture potential (Hart and Bryant, 1999). Ironically, most earthquake damage since that time has not been caused by ground rupture, but rather by ground shaking, usually exacerbated by liquefaction and poor construction.

Other States, and some Canadian Provinces are following the California example. Locally, formal zoning of active faults is required as in Utah; elsewhere, planning commissions are advised of potential seismic sources and secondary effects, such as tsunami runup in coastal Oregon, Washington and British Columbia. But seismic issues are not confined to obvious plate boundaries. The intra-plate, New Madrid seismic zone in the mid-Continent has received much study, especially from a paleoseismic standpoint. Indeed, "paleoseismic investigations" are increasing throughout North America, conducted by government agencies, academic institutes and private consultants (for example, Pipkin and Proctor, 1992). The attempt is to deduce the late Quaternary slip rate of near-surface faults, and thus to estimate recurrence and magnitude potential (McCalpin, 1996; Noller and others, 1999). Usually, 5 to 20-m deep trenches are excavated across suspected fault zones. The sediments and faults are documented on trench logs, and particularly diagnostic stratigraphic markers, such as buried paleosols, are often sampled for numeric or relative dating. All these efforts, however, are for naught when it comes to "blind thrusts,"□ faults that are usually too deep for normal trench exposure. However, there are often geomorphic indicators of these faults, such as asymmetrical anticlines, water and wind gaps and a host of other classic geomorphic features potentially indicative of neotectonism. For the seismologist and geotechnical engineer, seismic hazard issues increasingly revolve around the virtues, and limitations, of deterministic versus probabilistic analyses. Arguments abound, and likely will continue for years to come.

Slope Stability

Urbanization, particularly in western North America, continues expansion onto hillside terrain. Thus slope stability problems increase. The combination of mass-grading, construction of hundreds to thousands of new houses, and importation of urban water (landscaping and recreational use) leads to increased pore-water pressure and often, unfortunately, to mass-movements. The U.S. Geological Survey and many State and Provincial agencies have traditionally addressed the problem by laboratory research and by case-study analysis and by producing small-scale maps that depict areas particularly conducive to landslides or debris flows (Costa and Wieczorek, 1987; Turner and Schuster, 1996; Karrow and White1998). Additionally, symposia and field trips are often held; the participants typically include geotechnical engineers, geoscientists and urban and regional planners. Alas, many destructive landslides and other mass movements prove to be very site-specific. Accordingly, particularly in California, engineering geologists typically emplace borings and piezometers, excavate and log trenches, and ultimately reach professional conclusions about slope factors-of-safety (Slosson and others, 1992). Such calculations, though reasonable, typically do not, and perhaps cannot, take into account anthropic impacts that will likely contribute to near-future slope instability. Commonly, golf course, landscaping and other urban water additions, as well as poor maintenance of drainage systems, cause rise of local water levels, and thus to potential catastrophic slope failure. Particularly in the United States, the cause and responsibility of landslides and other environmental damage is fought over in the courts. Such litigation dealing with "product liability" and "construction defects" normally requires the testimony of scientific expert witnesses. Though perhaps socially abhorrent, such litigation provides an above-average income for many senior geoscientists.

Subsidence and Expansive Soils

Although there is little loss of life, the social and economic impact of ground subsidence and expansive soils is great. Subsidence and ground fissures caused by long-wall coal mining in the central United States are still being studied by government agencies. But hydrocarbon and groundwater withdrawal are detrimental environmental impacts that seemingly increase despite a proliferation of investigations and technical reports that characterize and recommend mitigation for these phenomena.

In arid and semi-arid regions of the southwestern United States, subsidence, ground fissures and differential settlement are increasing (Borchers, 1998). Not only does the problem involve groundwater withdrawal but, ironically, groundwater rise. A case in point: recent pumping of new ~350-m deep water wells in southwestern Riverside County (California) led to seismic rejuvenation of Holocene faults, to production of 300 to 400-m long, en-echelon ground fissures, and ultimately to damage to both houses and infrastructure. Ironically, at the same time and less than 10-km away, similar damaging fissures occurred. These fissures, however, resulted from importation of urban water, which eventually saturated collapse-prone sediments. Perched groundwater levels rose 30 m in two years leading to hydroconsolidation and differential settlement. New houses were extensively damaged, water lines and other urban infrastructure were severely impacted and, perhaps inevitably, litigation ensued (Shlemon and Hakakian, 1997). At least one positive benefit accrued: almost every geotechnical consultant in the area is now aware of the potential impact of anthropic-induced groundwater rise and thus, though inadvertently, has raised the local professional Standard-of-Care.

Geologic Hazards

The expression "geologic hazards" is increasingly used by North American governmental agencies and by private consultants. Perhaps not more than about 20 years ago, these "hazards" were considered to be normal geologic processes, such as seismicity, volcanism, and coastal erosion. But such terms do not convey the urgency for investigations that most geoscientists (and perhaps every other profession) think necessary to obtain government funding. Thus, the esteemed "Engineering Geology Branch" of the U.S. Geological Survey has been reconstituted as the "Geologic Hazards Group." Certainly many other governmental agencies, whether at the federal or state level, are doing the same. Even a casual perusal of the Internet shows that many jurisdictions rather proudly announce the "geologic hazards" of their particular area. We therefore are seeing the development of an often self-serving "geologic hazards industry." This "selling" of geologic hazards has indeed brought additional funding for much needed research in the environmental geosciences. Unfortunately, however, public perception of many geologists is changing, and perhaps not for the better. Rather than being regarded as unbiased, at least some view the geoscientist, pejoratively, as an environmental extremist. Accordingly, "the hazard of geologic hazards to geology" is a topic of interest to all geoscientists, from the viewpoint of income production, ethics and public information (Shlemon, 1999). Usually, whether good or bad, environmental geoscience research and public policy issues in North America are often exported throughout the world. The initial years of the 21st Century should see more of the same. International environmental geoscientists: be aware!

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