THE ECONOMIC AND ENVIRONMENTAL IMPORTANCE OF GROUND WATER
EDUCATION PROGRAMS THAT WORK FOR CITIZENS, COMMUNITIES AND DECISION MAKERS

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ABSTRACT

The sub-surface part of the hydrologic system is playing an increasingly significant role in local and regional economy for utility supply, irrigation and industry. There is also a growing recognition for ground water's role in aquatic and riparian ecosystem ecology. The challenge of developing water policy and implementing effective management strategies is growing in complexity, and with a finite (although renewable) resource base, the process is becoming progressively politicized. Water supply is under stress throughout the world and the challenge of balancing competing demands has provided an impetus to the development of education strategies for citizens, communities and decision-makers.

The challenge of communicating ground water information has been taken up by government agencies, professional organizations and NGOs. Education is a process, and to be effective needs to be crafted to suit particular purposes. Education strategies related to ground water are best developed around specific learning and behavior-change objectives. With the "stakeholder" involvement concept gaining momentum, ground water education to bring science to the non-expert can help stakeholders frame the issues, understand hydrologic cause and effect, and be involved as meaningful participants in protection and management decisions.

RESOURCE PRESSURES

As countries become more crowded and consuming there are increasing demands for land, energy, materials, goods and services; especially water supply. Two thousand years ago, the world=s total human population was less than 3% of the present total. Currently world population is increasing by approximately 150 people per minute and now exceeds 6 billion with absolute numbers increasing by 80 million people per year. By 2025 more than 3.3 billion people in 50 countries will face water stress or scarcity (Gardner-Outlaw & Engelman, 1997).

Eighty percent of all disease in the world can be traced to drinking and washing with unsafe water supplies. Even with low per capita water use (20-40 liters minimum for drinking and sanitation), lack of water limits community health, economic progress, and food production. Ground water sources are the only supply option in most rural areas.

Globally, 80 million hectares of farmland have been degraded by a combination of salinization and waterlogging (Hinrichsen, et.al., 1998) but world food production will require a two to threefold increase per hectare to meet 2025 projected minimum food requirements. Overall efficiency of irrigation worldwide is estimated as 40% (Postel, 1997). Ground water sources, and/ or conjunctively managed surface and ground water will become even more critical for food production.

Increased pumping and diversion of water is causing damage to ecosystems (Falkenmark & Widstrand, 1992). Publications such as Gore=s *Earth in the Balance* (1992) Gleick=s *Water in Crisis*, (1993), and Simon=s *Tapped Out* (1998) have helped promote scientific and political awareness of the interdependence of society and the environment. If aquifers are exploited in excess of natural recharge or become contaminated, there is real risk of environmental, economic and social crisis. The challenge is to meet growing needs from finite resources while maintaining (and restoring) the planet=s life support system.

SUSTAINABILITY

The ADublin Principles@ established by the International Conference on Water and the Environment in January 1992 recognized that water resources are finite and vulnerable and that sustainability should be a management objective. Sustainability is a logical basis for ground water management and protection policy. Sustainable water use supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle of the ecological systems that depend on it (Gleick et al., 1995).

Implicit in the word sustainability is a defined a level of water use. As a resource with great economic, environmental and political significance, ground water is of interest and concern to a wide number of constituents. The determinations of levels of use move beyond hydrology and encompass economics and political decisions. In reality, ground water policy may be a hybrid artifact occurring as a by-product of policies developed for areas such as public health, endangered species or agriculture

POLICY

It is important to integrate hydrologic information, economic forecasting and social planning into resource policy decisions. Information and informed explanation (education) are important for policy, particularly because many issues are complex. ABenign problems@ are those with a clear and logical definition with a specific disciplinary variable. AWicked problems@ have multiple and conflicting criteria for defining solutions (Rittel & Webber, 1973). Virtually all ground water policy issues are by definition Awicked@ even although some individual components, for example defining aquifer boundaries or estimating local population growth, may be Abenign.@ There can be a Awicked problem@ disconnect between scientists, policy makers and the public because technical, academic and engineering professionals may not be adequately integrated into the political decision-making process. An additional reality is that science may be neutral but scientists are not necessarily neutral (Walker & Mairs, 1999). Data sets do not in themselves provide answers. Education of the constituent groups that can influence policy makers can reduce the effects of misinformation from exaggerated “spin” of hired-gun experts.

Agency authority can provide regulations but regulations should follow policy; policy should not be formed by regulation. Acceptance by the regulated that there is a rational need for regulations is an important prerequisite to making rules workable. Education needs to be a key element of regulation in order to achieve cooperation and compliance. Voluntary self-policing is important for many aspects of ground water protection

In educating the public, the messenger can be as least as important as the message. There is an inherent tendency to disbelieve information from parties with a vested interest in a policy decision. One of the most important aspects of water resources policy is to ensure that those affected have an opportunity to participate. The earlier on in the process citizens are involved, the more likely they are to cooperate. Ideally the whole community should be involved in decision-making that balances the risks, costs and

benefits of water development/ protection/ allocation policy. Most policy makers want to have the support of the people they serve. Policies with public support are more likely to work!

MANAGEMENT

A management process is required to implement water policy. This can occur at many different scales and involve many different jurisdictions. Table 1 lists six decision-making criteria that are suggested as important for effective ground water management (Stone, 1998). Some of the criteria are outlined below, with the educational aspects discussed in more detail later.

COMPREHENSIVE APPROACH

The sustainability paradigm implies a long time frame for ground water management. Changing social demographics, evolving regional economics and potential technological innovations are ingredients for planning. Water management strategies should involve the interests of current and potential users. Including a broad base of technical experts can avoid professional bias in decisions, and collaborative agency oversight can preclude overarching claims of decision-making jurisdiction.

GROUND WATER A COMMODITY

The value of ground water includes its environmental/ecological values in addition to the direct benefits derived by private sector enterprise and the local, regional and national economy. There are some key economic questions that require assessment, such as: who is profiting from the current use of water? What is the value of water if used for some other purpose? Will a particular water management decision benefit one group more than another? Who has rights to the water? Carving up the water pie presupposes that someone knows the size of the pie? Mother Nature may unpredictably provide annual water pies of different sizes. In an arena of shortage, the calculation and prediction of pie-size puts the ground water scientists' work under close public scrutiny.

MANAGEMENT TIME FRAME

Water policy should address more than the short-term economic benefits that accrue to the direct user. If the policy includes built-in over-exploitation, then social costs of non-sustainability should be factored in and the price of the "exit strategy" from an over-exploitive development should be borne by the beneficiaries. Enlightened policies provide management frameworks to equably reconcile water availability and needs. Good science, informed citizens, and a long-term perspective of economic development priorities are essential ingredients to avert the social and economic consequences of over use. Sustainability has moved from a scientific exercise to political reality because of stress between human population and natural resources. The resource management principle is changing from, how much water is needed and where do we get it? to how much is there and how can it best be used? Management objectives are set by policy. Education can powerfully influence policy decisions.

HYDROLOGIC SYSTEM

There is a logical reason to consider all water, surface water or sub-surface water as a single resource. In the integrated resource concept, one person's down-stream is another person's up-stream; one community's wastewater is another community's source water and today's ground water is tomorrow's river base flow. The drainage basin (watershed) has long been recommended as an ideal unit for water management (Chorley, 1969). It is a fundamental prerequisite of ground water management that policy is based on an understanding of the local hydrologic conditions. A regional perspective is needed in cases where the groundwater occurs as part of a wider geologic system of recharge and storage (Stone, 1990). There may be strong jurisdictional precedent for separate surface water/ ground water management strategies but it is likely that an integrated approach will become even more prevalent. As watershed-

DECISION MAKING CRITERIA FOR EFFECTIVE GROUNDWATER MANAGEMENT (from, Stone, 1998)	
1	**Take Comprehensive Approach**
	? integrate hydrologic, economic and social planning ? consider all potential uses and users ? involve technical experts to ensure the practicality of decisions ? establish cooperative joint government/ agency authority over resources ? factor-in all alternate supply strategies
2	**Consider Groundwater a Commodity**
	? calculate the true costs of providing water ? factor-in the value of government subsidies or tax breaks ? make cost benefit analyses for all possible use options ? use appropriate predictive models of water need
3	**Define Management Time -frame**
	? take long term time frame in cost benefit calculations ? adhere to the water supply sustainability paradigm ? recognize potential implications of climate change
4	**Make the Hydrologic System the Basis for Management**
	? make decisions based on hydrological / ecological science ? use watersheds or aquifer regions as basis for assessment & management ? verify past hydrologic data and ensure integrity of current data sets ? consider full range of potential environmental impacts ? review case studies from similar geologic/ climatic areas
5	**Include Assessment of Social Costs**
	? review full range of national, regional and local impacts ? cost /benefit economic projections to include long term social costs ? assess impact of decisions on basic community water needs ? include basic “environmental justice” considerations
6	**Involve the Public and All Stakeholders**
	? identify a role for public in decisions ? develop the water use “stakeholder” concept ? provide “cause & effect” education to empower public to meaningfully participate ? include area residents and those directly involved in the “local water economy” ? allow national professional groups and researchers to participate ? prepare a comprehensive citizen awareness and decision-maker education program

focused management becomes more established and more data are shared there should be less "turf wars" among overlapping jurisdictions.

SOCIAL COSTS

Legal ownership of ground water varies considerably among and within countries. The uniqueness of water as a basic human need elevates the resource to a high plane of consideration in terms of equable allocation decisions. State by state in the US and throughout the world, there is a sad litany of instances of ground water resources being degraded by contamination. The concept of environmental justice has been applied to management decisions relating to environmental impacts as well as to resource allocation such as deepening large wells for "big-users" at the hydrologic (and social) expense of "little users."

PUBLIC AND STAKEHOLDERS

Decisions about water resources are usually too important to be made by a single group of specialists. Education can broaden the boundaries of inclusion. The challenge for the groundwater-educated super-elite (hydrogeologists & engineers) is to explain ground water's scientific "mysteries" to a range of constituencies so that the resource may be appropriately valued, cherished, protected and managed.

EDUCATION STRATEGIES

VESTED INTERESTS

The role of the media in highlighting local environmental issues and the ease of communication via the Internet has made it difficult for environmental issues to remain hidden. There is a growing recognition among the public of wider societal concerns for health, the environment and the quality of life. With demand greater than supply, overall public awareness and concern about ground water issues is also influenced by a greater recognition of vested interests (I want it for my water utility, I want it for my trout stream, I want to irrigate my crops, Its mine by right, I want it, I want it….). There are very strong territorial and possessive emotions concerning ground water that are particularly apparent when there are private sector proposals to develop resources, or if regional water plans involve water transfers. The possessive psychology with regard to water is particularly manifested if a development proposal involves transfer across political boundaries. The response can generate great interest in education strategies to educate the community about the value (scarcity) of its resources.

TOP DOWN

Many excellent ground water education programs are tactical elements of a public policy strategy, and are typically related to public health issues and often funded by government. Targets of such programs include informing the public about hazardous waste collection, creating homeowner awareness about the importance of testing private wells, encouraging riparian buffers and providing information about benign alternates to lawn & garden chemicals. An extension of this form of ground water education outreach extends to agricultural and construction practices where education is seen as a critical adjunct to regulation. Education is especially relevant in areas where individual behavior can have an impact.

The relative role of government and independent NGO groups in environmental education varies considerably. The ground water education programs of independent education groups may be funded from tax-based revenues, often on the basis of competitive grants. There can also be inter-government department funding of education programs that usually involves an agency transferring funds to a local unit of government for a specific education purpose.

BOTOM UP

Citizen groups, usually self-financed or with private sector funding, may use ground water education as a tactical element to influence public policy or proposed local water management strategies. Examples of

citizen concerns are; local opposition to planned industrial development near a local aquifer or a local campaign for government funding for regional wastewater disposal system. In such cases, education endeavors are often directed at fellow citizens with the intent of influencing ballots for specific legislation or management proposals. Many citizen concerns relate to land use proposals. The concern for water is often the most potent card to play in influencing opinion, but there may well be other issues such as increased traffic, opposition to low-income housing development, pressure on schools etc. which are the main underlying reasons for an awareness and information campaign in the name of ground water.

TRAINING

While much public education is aimed at non-experts, there is an important element of public education in many of the training programs for people directly or indirectly involved in water supply. This is particularly the case with development projects involving ground water. Community education is often an essential project element for ground water based supply infrastructure improvements. Community buy-in and acceptance of new water supply sources is essential for behavior changes needed to protect resources from contamination or overuse (Stone, 2000).

In all countries there are professions such as sanitarians, building inspectors, realtors, and septic system designers that are peripherally involved with ground water issues. Basic ground water education can greatly enhance their capability to "speak-up" for ground water as they go about their daily work. For example, when realtor (estate agent) lists a property with a well, knowledge of the significance of basic well construction and local ground water conditions can allow for a more accurate description. A sanitarian may be highly trained about the biology of organisms, but without some geologic and well construction education would have an imperfect understanding about potential contamination vectors.

STAKEHOLDERS

There is every reason to inform the public about the scientific, technical and economic aspects of water problems so that citizens can be involved in helping to formulate policy options. The concept of Astakeholders@ is based on the notion that many different groups may have an interest in being involved with policy decisions An important element of ground water education is to create forums for stakeholders to voice opinions and to support or challenge the scientific and economic basis for water policy. Framing the issues is a major challenge when creating a forum that has the intent of influencing public policy. Such forums or meetings should be seen to be balanced, collaborative and inclusive and not proscriptive or one-sided. There may be suspicion if one agency or entity dominates the process of selecting and promoting education forums or meetings.

ROLES FOR GROUND WATER PROFESSIONALS

Ground water scientists can play an important education role in selling their science to the public and hence serve as a link between science and decision-making. Ground water educators benefit from mobilizing armies of foot-soldier volunteers to carry the messages to their targets. Enthusiasm is a most critical element for a successful volunteer. Professional background in the arena of ground water, when appropriately channeled, can be a very powerful adjunct to enthusiasm for the resource. There are several obvious ways in which ground water specialists, in a volunteer role, can help bridge some of the "us and them" attitudes among, the public, interest groups, regulators and decision-makers. For example; by volunteering to support local education programs as a presenter; by offering to talk to school students; by encouraging clients to include a line-item for ground water education in contract budgets, and by promoting active education outreach as an objective for professional associations (Stone, 1993). Volunteer public education assistance can be particularly effective from academics, most of whom have ready teaching material that can be adapted for citizen audiences. Ivory towers can serve as lighthouses to illuminate ground water issues, and hence lead to enlightened management decisions. Providing objective information without bias is a prerequisite for effectively communicating with the public and local communities. Citizens view universities and their academics as sources of unbiased information.

JARGON & EDUCATION TOOLS

Awareness, information, training, teaching, public relations and outreach are words often used indiscriminately under a broad umbrella of education. They are all important! Choosing the best teachable moment can have a positive impact on the effectiveness of the message. Targeting education information by Arifle-shot@ may achieve more results than making a lot of education noise by a Ashotgun@ approach. Workshops, water festivals, site visits, development of school curriculum materials, interactive simulation programs, videos, teacher training, posters, pamphlets, informational press releases, etc. are a few examples of the potential educational tools that can be used. In all cases, the objective of a proposed education initiative needs to be established in order to prepare the best strategy. Almost any initiative can incrementally add to overall understanding of the importance of ground water management and protection. One of the greatest problems in helping people understand the issues is to "educate" those people who think that they understand!

EDUCATION RESOURCES

The development of education programs can benefit from professional input. Just as experts are needed to advise on technical aspects of water science and engineering, so too should community education experts be consulted to help choose among the huge arsenal of potential techniques. The constant need for promoting awareness can be compared with the annual advertising campaigns of multi-national companies. Everybody knows that the particular products or services exist – but constant reminders, via a variety of media stimuli are judged to be important for sales. Educators are sales-people too, and an effective education campaign will benefit from a level of attention and planning similar to a major commercial marketing campaign.

There is an extensive range of educational experiences and case studies that can be used or modified to suit local ground water education needs. The proceedings from an AWRA water education conference (Warwick, 1997) and a US Environmental Protection Agency conference (USEPA, 1995) are a good starting point for ideas on education. There are hundreds of education resources available from organizations such as the US Environmental Protection Agency and the US Geological Survey. These, and other sites can be accessed from the LINK sections of web sites of ground water education organizations such as the Groundwater Foundation (www.groundwater.org) and American Ground Water Trust (www.agwt.org and www.privatewell.com).

CONCLUSION

The achievement of a basic understanding of ground water science by decision-makers helps the successful transition from awareness to concern, and from concern to action. The key to long-term education success is teaching decision makers how science works, not simply what science has discovered. Citizens made more aware of their local aquifers will feel connected in a way that enhances a feeling of natural synergy between people and their resource base. There is an important resource stewardship role for "ground water literate" stakeholders at all levels of decision-making. Ground water educators speak for the water molecules in all the world's aquifers. Like evangelical preachers – ground water's cadre of educators is convinced that the environment, the economy and quality of life are enhanced by their work. We need more converts!

Note - [One of the most important elements of ground water education initiatives is to get them paid for! Grant funding can only go so far, and achieving sustainability for education programs is a major challenge for NGO education administrators. Program financing and program evaluation are two crucial components of ground water education that justify attention but are not considered in this text.]

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