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Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta

BEN CROW

Sociology Department
 University of California
 Santa Cruz, California, USA

FARHANA SULTANA

Department of Geography
 University of Minnesota
 Minneapolis, Minnesota, USA

Water plays a pivotal role in economic activity and in human well-being. Because of the prominence of water in production (primarily for irrigation) and in domestic use (drinking, washing, cooking), conflict over water and the effects of gender-influenced decisions about water may have far-reaching consequences on human well-being, economic growth, and social change. At the same time, social conflicts and social change are shaped and mediated, often in unexpected ways, by the natural conditions in which water occurs. The social relations of water are poorly understood. This article introduces a framework for disaggregating conditions of access to water and uses it to examine three pressing questions in Bangladesh. First, extraction of groundwater for irrigation has made many drinking-water hand pumps run dry. Second, increasing use of groundwater for drinking has been associated with the poisoning of at least 20 million people through naturally occurring arsenic in groundwater. Third, the article examines some of the ways access to water has been changed by the rise of shrimp aquaculture for export. This article highlights new directions for the analysis of interactions among water, class, and gender. The existing literature has tended to focus on the implications of gender analysis for government policy, especially development projects and water resources management, and for women's organization. In this article we begin to sketch some questions that arise from a concern to understand the broader context of social change.

Keywords arsenic, Bangladesh, gender, irrigation, shrimp aquaculture, social change, water conflict, water resources

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Address correspondence to Ben Crow, Sociology Department, University of California, Santa Cruz, CA 95064, USA. E-mail: bencrow@cats.ucsc.edu

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LIBRARY IRC
 PO Box 93190, 2509 AD THE HAGUE
 Tel.: +31 70 30 689 80
 Fax: +31 70 35 899 64

BARCODE: 17648

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In urban areas of the industrialized world, access to clean, plentiful water is almost universal and approximately equitable. Well-established arrangements deliver processed water through pipes and faucets to virtually every home and enterprise at costs that are small in comparison to the revenues of most enterprises and to the incomes of all but the poorest households. These arrangements involve almost no input of domestic work for households and little input of work by enterprises. Access to water has been moved from a household to a public responsibility. The history of this move, with the conflicts and choices it involved and the social consequences it brought, may be largely forgotten in many parts of the industrialized world.

In the global south, particularly in rural areas, access to water is generally more problematic, more differentiated, less secure, and frequently requires substantial expenditures of work, time, and money. In this article we examine what this means in the case of Bangladesh. We are especially interested in ways in which access to water may be influenced by gender and material inequalities. Bangladesh is a small, deltaic country with a population of over 120 million, a low level of economic productivity (gross national product [GNP] per capita is currently estimated at about \$250), and an intense subordination of women. Sharp seasonal fluctuations in water supply bringing both drought and flood, the seclusion of women, a high population density, and the low level of economic productivity in Bangladesh, bring issues of water, power, and gender to the fore.

The first section of this article seeks to disaggregate the social relations of access to water in the global south, and to show how gender and material inequalities intersect to influence water deprivation and water security. This discussion is followed by a brief review of the literature on water and gender that highlights the contributions of this literature to the rethinking of a core sociological issue, the relation between structure and agency. In the next section, we describe the various social uses of water in Bangladesh and the ways in which those uses interact with gender and class relations.

Then in the third section we turn to three pressing cases of conflict over water. The first concerns conflict over the use of groundwater for drinking and irrigation. The extension, over the last 30 years, of groundwater use to support Green Revolution agriculture has jeopardized the attempt to provide universal access to disease-free drinking water from the same groundwater sources. Overpumping for irrigation has lowered water levels leaving many drinking water handpumps dry for part of the year. In the second case, the provision of nearly universal access to what was thought to be clean drinking water has led to large scale arsenic poisoning. Arsenic occurring in the groundwater is poisoning some 20 million people. These two cases involve conflicts over progress with gender implications and unexpected environmental outcomes. Nature interacts with conflicts between the goals of economic progress and better health. We describe the current situation, and the gendered impacts of the two cases.

The third case concerns shrimp aquaculture. In the last decade, shrimp aquaculture has been one of the largest sources of foreign exchange for the economy of Bangladesh. We examine some consequences of the expansion of shrimp farming for gender relations and the use of water.

This article raises three questions with the potential to extend a small but growing literature (see particularly Cleaver 1998) on gender and water:

1. How are different modes of access to water influenced by gender relations and material inequalities?

2. What roles may nature, specifically hydrological and geophysical conditions, play in social conflict and change?
3. How can the analysis of water and gender relations be extended beyond a focus on development projects to look more widely at gender and water in social change?

Water, Class, and Gender

In the countryside of the global south, access to water is achieved through a range of social relationships falling into four main modes of access:¹

1. Ownership of land and a pump providing access to groundwater or a water course.
2. Market access—purchase of water, such as from the owner of a pump.
3. Common property access—obtaining water from river, pond or public tank through some communal rights of access.
4. State-backed provision—local or national government projects, such as municipal tap water, or pumped water in an irrigation project.

Each of these modes of access has particular characteristics, or social dimensions: cost, labor time, decision making (agency), historical trajectory or long-term dynamics, and response to external shocks. For each category of access it is possible to identify social conditions that ensure *water security* (adequate quantity, quality, and reliability) for some households and enterprises and *water deprivation* for others.

Households that have accumulated land and investment resources, to give an example in the first mode, can pump water directly. That supply may be clean and reliable, depending on natural conditions and upstream uses of the water, and may require little additional expenditure of work time and money. Households without land may have more restricted access to water. Property relations, in other words, establish differential conditions of access to water that exclude some households and some enterprises.

Villages or regions, to take an example of the third mode of access, may have established common rights to rivers or ponds, social arrangements for maintaining those water sources and for rationing their use; water user groups or associations are often formed at the village level to mediate water access and rights, although formation of such formal bodies has increasingly come under criticism as being exclusionary or favoring village elites. Although common property rights may give wide social access to water, often the water is of poor quality and the work time involved in obtaining it may be high. As population expands and common property resources become more scarce, the social arrangements for maintaining the resource and governing access to it may come under pressure and conflicts may intensify.

In most rural regions of the global south, access to water is obtained through all four modes. The access to water of both households and enterprises may then be highly differentiated by material and other social divisions. Rich and influential households may have preferential conditions of access, and different sources of water, compared to those of poor households. The quality, reliability, and costs of water for a particular household will be influenced by a range of characteristics including conditions of the water source, geographic location of the household or enterprise in relation to the water source, past social investments in water infrastructure, and the social, economic, and even political position of a household or enterprise.

From this disaggregation of the social relations of water, it is clear that material inequalities influence water security and deprivation through a range of processes operating at different social levels. These processes include property relations, inequalities of income, state provision, rules of access to common social property, and social status. Conditions of access to water for many poor households constrain both health and livelihood. Poor households generally get access to unsafe water, and their access may also be insufficient to sustain potential livelihoods, for example irrigated agriculture. A recent review of participatory poverty assessments in several African countries concluded that better water supplies were consistently perceived by the poor as a high priority (Booth et al. 1998, 7).

What may be less obvious from the discussion so far is that gender relations interact with material inequalities to influence access to water. Gender relations influence the social relations of access to water in at least three ways. Firstly, there are, in all societies, gender-based divisions of work. In many societies, women have primary responsibility for organizing and undertaking domestic work (Elson 1995, 259). This work includes a range of activities: maintaining daily life (cooking, cleaning, washing clothes), managing the health of the household, and caring for and raising the children. So where household access to water requires significant input of work time, the women and children of a household frequently do this work. Women tend to work longer hours than men do in many societies (Pearson 1992). The work involved in gaining access to water may then lead to difficult choices. Access to higher quality water might have to be forgone, for example, in order that children in the household can be kept safe or other household chores completed on time. Young women and girls may be kept away from school to undertake the time-consuming daily task of collecting water.

Water collection is a major part of the work of women in rural areas of the global south. There is little systematic data on this work, but fragmentary evidence from Africa and Asia suggests that the time women spend collecting water can be very significant. In Senegal, women spend 17.5 hours per week collecting water. In Mozambique, they spend 15.3 hours per week collecting water in the dry season. In the Baroda region of India, women spend 7 hours per week collecting water. Observations from Nepal confirm the important role of female children in the collection of water, with girls of 10 and over devoting almost 5 hours per week to the task (United Nations [UN] 2000). In Bangladesh, women and girls have been found to walk between 2 and 5 hours each day to fetch water (Shamim and Salahuddin 1994).

Second, in most of the world, and certainly in South Asia, the overwhelming majority of productive assets, that is, land, factories, and finance, are owned or controlled by men. This means that those forms of access to water that involve ownership of property, mode 1 already described, tend to be dominated by men. Women also generally experience disadvantaged access to markets (Sen 1996), including markets for water, mode 2. In addition, decision making in state offices, mode 4, and in communal institutions (Agarwal 1997a; 2000), mode 3, tends to be dominated by men. There are thus reasons to believe that decision making is male dominated in all four modes of social access to water.

Third, policy discourse and local norms may situate economic uses of water in a male domain and domestic uses in a female domain. Then the subordination of women, giving men as a group more social and economic power, may influence priorities for public investment and collective decision making in water. Uses of water identified with men, such as irrigation, may then be better represented and

more knowledgeably discussed in societal forums at all levels than uses of water identified with women, such as drinking, cooking, and washing.

How do gender relations and material inequalities intersect to influence the social uses of water and its outcomes? Material deprivations of poverty may intersect with the subordination of women to amplify health hazards for poor households. Poor women's access to water may be doubly disadvantaged, first by the household's weak grasp on resources and second by the low priority given to women's work, knowledge, and responsibilities. A fuller understanding of this double deprivation requires an investigation of the links between intrahousehold bargaining and extrahousehold processes (Agarwal 1997b, 37), but it may have far-reaching consequences for the life expectancy of the poor.

Borders and Practices, Agency, and Structure

One achievement of the small but rapidly growing literature on gender and water has been to question social practices of water use in relation to the interests of men and women (Van Wijk et al. 1996; Cleaver 1998). The allocation of water is gendered. Men and women have claims justified and given priority by gendered ideas about social roles. This achievement is related to long-standing and fruitful engagements in the broader feminist literature with the border between productive (production of goods and services for barter and exchange) and reproductive (services and goods consumed in the home) activities. Two recent papers (Zwarteveen and Endevelde 1995; Jackson 1998) highlight the significance of this border for the gendered relation between social structure and agency.

Zwarteveen and Endevelde explore the influence of the border between the economic and domestic spheres on the way academics think of the peasant household as either a farm or a family. In a paper entitled "Rural Women's Questions Are Also Agrarian Questions" (1995), they suggest that the conceptual reintegration of farm and family may illuminate social change in agrarian societies because it enables recognition of cooperative as well as conflictual relations between men and women. They cite research from Nepal, Sri Lanka, and Ireland suggesting that farm households in which husband and wife have a "good relationship" achieve high returns to land and labor. Recognizing that a peasant household is both family and farm, they suggest, illuminates gender struggles:

Rather than over women's labor to the ("male") farm per se, as many feminist scholars have tried to argue, most gender struggles in family farms are likely to arise either as a result of the failure of farming to sustain subsistence and reproductive needs, or over the possibilities to produce surpluses.... Rather than escaping from male control... [women's preference] to work on their own fields is also due to the fact that labor productivity on these plots was higher and that working on own plots was thus better in terms of the family's overall livelihood strategy. (Zwarteveen and Endevelde 1995, 9)

Jackson's paper asks: "how do we deal with the tension between approaches to gender and development that emphasize the social structural constraints on women... and those that emphasize the agency of women as acting subjects?" (Jackson 1998, 311). Her answer to the question is to seek to connect personal experience, subjectivity, with social constraints, embodied livelihoods, in the idea of

the *embodied subjectivities* of men and women. She applies this idea to shed light on the greater achievements of governmental intervention in domestic water supply compared to irrigation:

Could it be that the greater "success" in domestic water development is connected to aversion by women to irrigation work and/or to a greater commitment to domestic water improvements? In other words is it women's agency as much as exclusionary, male dominated, social structures that "explains" such outcomes? (Jackson 1998, 319)

These two papers are problematizing, bringing back into question, borderlines that may have been taken for granted in much academic work on the global south. Zwarteveen and Endevelde suggest that the conceptual separation of farm and family, or enterprise and household, hinders understanding of the causes of gender conflict and the consequences of cooperative or conflictual gender relations for productivity and well-being. Jackson refocuses our attention on the possibility that women's agency may be as important as structures of male domination in the success or failure of government-backed projects improving access to drinking and irrigation water. Jackson's paper connects structure and agency in the idea of embodied subjectivities, women's experiences in the context of particular livelihood constraints.

We suggest that research that traverses the divide between domestic and economic spheres, as in these two papers, provides better illumination of the relation between structure and agency. Then disaggregated analysis of access to water enables the social dimensions of access to be highlighted:

- How is labor distributed between public/social and private/household domains, and between men and women?
- Who makes decisions, and in what context?
- Has the historical trajectory of particular modes of access excluded poor households or women?

In the next section, we describe the different social uses of water in Bangladesh.

Social Uses of Water in Bangladesh

Drinking and Cooking Water and Health

The expansion of access to groundwater for drinking purposes in Bangladesh was expected to reduce water-borne disease from consumption of polluted surface water. Filtration through soils removes most bacteria from water, so groundwater is usually safer than pond or river water. As Azad (1999) explains, the extension of access to groundwater "was a pride of Bangladesh . . . it brought 97% of the population under the coverage of safe drinking water." The United Nations Children's Education Fund (UNICEF) provided much of the impetus and financing for the drilling of rural tube wells (so called because they sink a solid tube down to the groundwater aquifer), and the delivery of hand pumps to pump water to the surface. With donor, government, and nongovernmental organization (NGO) support, as well as private installation, the number of tube wells in Bangladesh rose dramatically in the last two decades in Bangladesh to over 9 million in 2000.

In Bangladesh, women are the main managers of water for domestic purposes (drinking, washing, cleaning, bathing, and cooking) as well as for some subsistence

production in homestead gardening or raising of poultry and livestock. Women use water from different sources, including tube wells, ponds, canals, ditches, and rivers, depending on availability, proximity, and purpose of use. The water supply system in rural Bangladesh is not a fixed system but a set of water sources about which choices are made, and negotiated, often on a daily basis.

Class and location in rural Bangladesh differentiate access to domestic water. More prosperous households generally own deep tube wells, providing cleaner water. Wealthier women thus have better access to cleaner water than poorer women (Shamim and Salahuddin 1994). Access to water is differentiated by location in that those households nearer a functioning tube well are likely to use groundwater more often. However, any tube well has to be shared among different users. It is common for private owners to restrict access to their tube well or to charge a fee (although the latter is less common than the former). Tube wells available in public places such as schools, mosques, and bazaars often provide the only source of clean and safe water for rural households that do not have private tube wells. But these are often broken or inadequately maintained, forcing many to depend on good relations with wealthier households for continuity in access to reliable water (fieldwork observations 1998²).

Overwhelmingly, proximity dictates the source and use of the water, particularly for poorer and female-headed households. Several trips must be made each day to the nearest tube well or surface water body to meet water needs, with women and girls devoting several hours each day to ensure household water security. The distance to be covered can range from a few yards to several hundred yards. Women and girls may walk 2 to 5 hours each day to fetch water (Shamim and Salahuddin 1994). Polluted water sources are used when time constraints are too high. Young girls are often responsible for getting water several times a day. Because drinking water is constructed as a domestic responsibility in the female domain, the education of young women may be adversely affected. Often, daughters-in-law or younger women are sent to fetch water, because this is seen as a more menial task by more powerful women in a household. The burden of carrying traditional water pitchers (*Kolshi*) on the hip can cause difficulty during pregnancy and deformity in posture. Similar complaints have been made against the widely used *Tara* pumps, which are difficult and cumbersome to pump in order to procure groundwater. In instances where a long walk is required to reach the nearest functioning tube well, many families use closer polluted surface water (fieldwork observations 1998).

In sum, there are material and gender inequalities in access to water for drinking and cooking water. Access to drinking water is primarily through ownership and common property modes. Market access, in the form of bottled water, has started in Bangladesh in the last few years, but is not widely available in rural areas and is expensive. State-backed provision in rural areas has been limited to the provision of village hand pumps that, as noted, are often inoperable.

Washing Water, Sanitation, and Privacy

Women in rural Bangladesh are careful to maintain privacy and socially acceptable decorum in bathing and cleaning in public. Most households bathe in ponds around the homestead, and women often bathe at different times than men and may bathe clothed to maintain decorum. If women use tube-well water for washing, usually in better off households, a makeshift enclosure of banana leaves is sometimes used. Few rural households have closed latrines, but the poor are especially unlikely to

have them. They often await nightfall to use the open latrines. This makes it more difficult for women to maintain privacy in a conservative culture that emphasizes women's decorum. In some cyclone and flood crises, when privacy is particularly scarce, relief agencies have provided special bathing shelters to give some privacy to women.

In this case also, there are class and gender inequalities. Rich households are much more likely to have a private pump, pond, or tank within, or in close proximity to, their household compound. In these households, women can maintain their privacy in bathing. Poor women may only be able to obtain privacy if they bathe early in the morning, adding a further pressure on their time. Here, too, trends toward the private appropriation of surface water sources may further limit poor women's ability to meet social norms. Similarly, the increasing conversion of homestead ponds for fish culture by men is reducing the access of women to clean pond water. This leads to conflict over time and space at the ponds, and an increased presence of men at times when women seek privacy.

Irrigation

Over the last 30 years, agricultural output in Bangladesh has increased dramatically. In the 1970s and early 1980s substantial food imports were required. By the late 1980s national self-sufficiency had been achieved. Increased agricultural output was attained largely through the adoption of Green Revolution technologies and practices: nutrient-responsive seeds, industrial fertilizers, elements of agricultural mechanization, notably irrigation, and a more intense use of hired labor.

The "leading technology" of the Green Revolution was the mechanization of irrigation through privately owned pumping of groundwater. Without timely and plentiful supplies of water, industrial fertilizers could not be taken up by the new high-yielding varieties of rice and wheat. In the past, under British colonial rule and long before, irrigation in South Asia had been achieved through collectively organized canals. In contemporary South Asia, state-organized delivery of irrigation water through canals has proved unreliable and inefficient. Large dams and canals for irrigation have been constructed since Independence, but they have not increased irrigation water supply nearly as dramatically as irrigation tube wells.

In terms of the access modes introduced in section 1, ownership of land and mechanized pumping of groundwater has provided the main form of access to irrigation water for the Green Revolution. Wider access to irrigation water and the livelihoods it makes possible has been promoted through the management of irrigation tube wells by landless groups. These initiatives have, however, been on a small scale and have had mixed results (Wood 1984; Wood and Palmer-Jones 1991). In the last two decades, the growth of water markets distributing water surplus to the owner's requirements has been noted (Palmer-Jones 1992; Boyce 1987). There has been debate about the equality of these markets (see contributions to Rogaly et al. 1999), but less has been noted about their implications for gender.

The rise of tube wells and water markets to distribute tube-well water has been associated with increasing male control over water. New technologies involve new property rights, usually defined as the rights of men. Agarwal (1994) has made a powerful argument that male control of property, particularly land, is one way in which women are subordinated. Several NGOs have promoted the formation of poor women's pump groups in Bangladesh. Van Koppen and Mahmud (1996) report they have been successful in many areas. There are, nevertheless, uncertainties about

whether women retain control even under these initiatives. The general trend is male domination in irrigation pump schemes and water selling markets "leading to less control over the incomes from such water assets" by women (Jordans and Zwarteveen 1997). At the same time, households with no land rights have no direct water rights either. Land rights, in a country with a significant percentage of the rural population landless, establish water rights. The development of irrigation has consolidated men's power over production and has given a new productive asset, irrigation water, to those with land and pumps.

State-backed irrigation projects in Bangladesh, as elsewhere, have overlooked nonmonetized agriculture and women's production. Field observation suggests that almost all rural households have kitchen gardens that are worked and managed by women. There are few studies of kitchen gardens anywhere in the world. In Bangladesh, kitchen gardens are watered and maintained by women and provide significant contributions to nutrition and household food security. These water uses and needs have not been included in current water resource schemes (UNDP, 1999). Irrigation pump water is generally used for field crop production. Those aspects of production which are managed by women, fruit and vegetable production and the rearing of livestock, do not have government-backed irrigation support.

In sum, the expansion of irrigation in Bangladesh has been through ownership and market modes of access, tending to favor richer households and to enhance men's control of water. There have been some counterinitiatives to give control of pumps to the landless and to women, but they remain small in scale and of uncertain efficacy. The importance of women's productive activities, livestock and homestead gardens, has generally been overlooked in state schemes, and the provision of water from private irrigation sources is not known. Irrigation tube wells, it should be noted, are often situated at some distance from a family homestead.

Groundwater, Progress, and Poisoning

Groundwater has been pivotal to two social achievements in Bangladesh: food self-sufficiency and greater access to biologically safe drinking water. Neither of these would have been possible without the expansion of groundwater use. In the early 1990s however, it became apparent that extraction of groundwater required for the Green Revolution had set back access to biologically safe drinking water. Shortly thereafter it also became clear that access to what was previously considered clean drinking water was associated with what has been called the world's worst case of mass poisoning. We describe these two conflicts in turn.

Gender Conflict Mediated by Nature

In Bangladesh, the extraction of irrigation water using tube wells has begun to lower water tables across the country, threatening access to clean water. Between one-third and one-half of drinking-water hand pumps may be left dry for some parts of the year (Sadeque 1996).

Electric- or diesel-powered irrigation tube wells can pump from deeper levels than drinking-water hand pumps can reach. Operating the lever of a handpump creates a partial vacuum at the top of the pipe that the surrounding air pressure fills with water, thus creating a pump. This process is limited to a depth of 25–30 ft by the weight of water that air pressure will sustain. In contrast, many of the larger, "deep" irrigation tube wells place a mechanical pump at the bottom of the well. These

pumps are not limited by air pressure and can therefore pump water from much greater depths. Deep tube wells can lower the groundwater below the level to which shallow wells (which constitute the majority of the homestead drinking water tube wells) can operate. Consequently, many shallow, hand-pump tube wells are left inoperative for several weeks or months during the dry season.

In a study, Sadeque described the problem in these terms:

The availability of groundwater is dependent on the properties of the groundwater storage reservoir and the annual recharge from rainfall, rivers and flooding. Seasonal lowering of the groundwater level caused by increasing groundwater development runs the risk of periodic tube-well failure due to large annual variability of rainfall distribution. (Sadeque 1996, 2)

This lowering of groundwater tables creates an important, but largely unreported, conflict over water. In this conflict the dominant, and male-dominated, priority of government, economic growth, clashes with lesser priorities of government, health, and domestic water supply, reflecting women's practical interests.

Mass Poisoning

There is a further setback to the achievement of access to safe drinking water. Over the last few years, there has been growing concern about arsenic in the groundwater of Bengal, both in Bangladesh and in the adjacent Indian state of West Bengal. Arsenic contamination of groundwater has been confirmed across large areas of Bengal. Many parts of Bangladesh are severely affected, with over 20 million people currently exposed to contamination and 70 million more potentially at risk.

Recent geological investigation suggests arsenic occurs naturally in the deltaic sediments that lie under much of the country (Bangladesh Government 2000, 9), but the causes and timing of the release of arsenic into groundwater are still subject to debate. There is a possibility that irrigation withdrawals caused the release (Harvey 2002, 6-8). The use of groundwater for drinking has turned impurity into mass poisoning. Tube wells are contaminated in 59 out of 64 districts in Bangladesh, and 1 in 3 tube wells in affected areas are producing water with arsenic at higher than acceptable levels of 0.05 mg/L in many parts of the country (National Conference 1999). World Health Organization standards for arsenic in drinking water are lower than those of Bangladesh, at 0.01 mg/L. Many deaths from arsenicosis have already been reported, and the number of patients with arsenicosis is increasing, since arsenic poisoning may take from 2 to 14 years to develop (World Bank 2000).

Arsenic contamination varies spatially, whereby tube wells in the same village are contaminated to different extents, leading to heightened pressures on the ones that are producing water of low arsenic levels. Arsenic contamination also has been found to reduce with depth, such that deeper tube wells produce less contaminated water. Recent study suggests that deep aquifers in Bangladesh are uncontaminated and that vertical percolation from shallow to deep aquifers is unlikely to be widespread (Bangladesh Government 2000, 11). But these views are contested. And there is also fear of arsenic entering the food chain from the irrigation of crops by contaminated groundwater. If this is happening, even larger populations may be exposed to arsenic poisoning.

The agencies most frequently blamed for the crisis are those agencies that promoted the dissemination of hand pumps for drinking-water provision: UNICEF (United Nations Children's Education Fund) and the Bangladesh

government's Department for Public Health Engineering. It is ironic that the agencies most obviously concerned with health should have played so prominent a role in developing access to poisonous drinking water. That irony should not overshadow the fact that lives saved through access to groundwater far outnumber the likely deaths from arsenicosis. It is estimated that the decline in diarrheal disease brought by access to clean water halved infant mortality rates (World Bank 2000). However, lack of adequate monitoring for arsenic led to the exposure of millions of people to arsenic-contaminated groundwater.

Action

The major thrust of government and international agencies is to identify contaminated tube wells. United Nations Development Program took the first steps in launching an emergency program in 1996 to identify arsenic-affected villages and provide basic treatment in 400 villages. Other donor organizations and government bodies followed suit. Wells are being tested and painted red when they are found to contain unacceptable arsenic levels. But only a fraction of an estimated total of 9 million tube wells in Bangladesh have been tested. The task of identification is made more difficult by the absence of adequate supplies of simple field tests for detecting unacceptable levels of arsenic. Testing currently requires expensive equipment, for atomic fluorescence spectrometry, which is not portable to rural areas. Cheaper and simpler field kits are being developed for various agencies to test and identify contaminated tube wells.

Even with complete identification of contaminated wells, rural households are left facing a dilemma: Use river or pond water and face water-borne disease, or use groundwater, if it is still within reach of hand pumps, and face slow poisoning from arsenic. Families without alternative sources of drinking water continue to use arsenic-contaminated tube-well water, and the response to poisoning has been slow and incomplete (e.g., Milton 1999).

In August 1998, the World Bank launched a \$32 million Arsenic Mitigation Water Supply Project with an emergency component (finding arsenicosis victims and contaminated wells) and a longer term component identifying alternative water supply options. However, by late 2000 this project was mired in conflict and bureaucratic haggling, and little had been achieved.

At present the treatment of arsenic-contaminated water is not widely available and is too expensive for most rural households. It has been suggested (Nickson et al. 1998) that simple aeration of arsenic-contaminated water may lead arsenic to be scavenged by iron in the water and precipitated as sediment. More recent geological findings seem to cast doubt on the chemical basis of this diagnosis (Bangladesh Government 2000, 6). Other researchers have suggested that the absence of naturally occurring selenium could make low levels of arsenic particularly toxic (George et al. 2000). If this suggestion is correct, addition of selenium dietary supplements could greatly reduce the toxicity of arsenic ingested from groundwater.

Implications for Class and Gender

The arsenic poisoning case is structured in several ways by class and gender. By chance, the geophysical distribution of contaminated water means that rich households, with deep tube wells, may have access to uncontaminated water. The worse nutritional status of poor households, and particularly the women of those

households, may mean that arsenic contamination has more severe physiological consequences for them.

The identification of contaminated wells may lead to greater conflict over uncontaminated water (i.e., the tube wells that are not marked red by government officials in the contaminated tube-well identification drive), and greater hardship for women procuring the water. Our analysis of the characteristics of different modes of access to water, and the contributions of Jackson (1998) and Zwarteveen and Endevelde (1995), emphasize the importance of women's labor time. The constraints on women's time, and the additional work time involved in obtaining water from noncontaminated sources, are likely to encourage continued use of contaminated wells.

The gendered impacts of arsenic contamination of water are also becoming evident in other areas of women's lives: health and social status. Since arsenicosis causes skin ulcers and lesions, and many other symptoms, women and girls afflicted with arsenic poisoning are suffering disproportionately both in terms of lack of medical attention and in being ostracized. Marriageability of young women in arsenic-affected areas is falling, and many women having visible symptoms of arsenicosis are being abandoned by their husbands (*New York Times* 1998). Mass panic and superstitious fears may increase the ostracization of women in arsenic-contaminated areas, as has the misplaced fear that arsenicosis may be contagious. All this points to the serious social consequences of groundwater poisoning for women in particular, even though arsenicosis can affect an entire family.

Shrimps and Gender Relations

Another example of changes in water use with implications for gender and class relations arises from the shrimp export industry. A shrimp export industry began to flourish in the coastal areas of Bangladesh in the 1980s. Shrimp exports, mainly of the marine shrimp (*Penaeus monodon*, or black tiger shrimp), found a niche market in Japan, Western Europe, and the United States. Shrimp exports contributed 8–10% of total export earnings in recent years. Considerable tracts of land, particularly in the southwest, have been turned into saline ponds where shrimp are cultured, and increasing numbers of people are involved in the industry (Sultana 1998).

In many areas, richer farmers forcibly take land from poorer people for shrimp farms, and often these shrimp farm owners are from outside the area (Khatoun 1995). The rural poor then become laborers who collect wild shrimp larvae (or fry) from coastal rivers and marshes. In the southwest of Bangladesh, the Sundarban Mangrove Forest, the largest tract of mangroves in the world, is being threatened by the expansion of shrimp farming.

Social tensions and ecological disruptions in such areas have been widely reported (Rahman 1994). However, gendered impacts of the rise of shrimp farming have not been adequately documented or addressed (Datta 1995; Khatoun 1995). As more and more families become laborers for the shrimp farms, increasing numbers of women and children are becoming shrimp collectors and shrimp processors. Although this is being heralded as employment generation by the industry, the overall impacts of the industry on the lives and livelihoods of rural women are not considered (Sultana 1998).

Shrimp ponds, which require saline water, are made by constructing canals that bring sea water to existing or newly dug ponds. Land previously used for rice cultivation and ponds used for washing and bathing are taken over by shrimp farming. The extent of salinity in groundwater may also be increased by these changes.

Women have farther to walk to collect drinking water when both ground and surface waters are made saline and polluted with chemicals by shrimp ponds. Use of tube wells in coastal areas is not common, since the groundwater is salty, and most people use pond water or rainwater in the monsoon season. But in the dry season, it is difficult for women to procure potable water, and they have to walk considerable distances to freshwater ponds to procure water. Many women also face harassment, on their way to collect water, from shrimp-farm guards, who fear that the women may steal shrimp (fieldwork observations 1999). Water concerns are differentiated by class in coastal areas. Richer households can generally create and maintain fresh water ponds, or they can afford to purify water for consumption. Poorer women, by contrast, may have to walk 2 to 5 km to get drinking water, or provide free labor in return for access to closer water sources.

A decline in the diversity of women's income sources has been noted (fieldwork observations 1999). Agriculture is shrinking in the coastal areas, reducing the diverse and varied tasks that women were engaged in before (e.g., weeding, harvesting, rice husking). They now spend most of the day in rivers and creeks to collect shrimp fry, often standing in waist-deep water, which has increased health problems (e.g., skin diseases) and also exposes them to the dangers of attacks from small sharks in the coastal rivers.

Homestead production, both kitchen gardens and domestic livestock, is reduced as a result of the increased salinity of domestic water. Gathering of various livelihood resources from mangrove forests is reduced as the area of shrimp cultivation expands. Loss of mangrove areas and other public lands and waterbodies as common pool resources appears to have had a greater impact on women than on men in coastal areas (Lopez-Rodriguez 1996; Datta 1995). A decline in nutritional diversity is suspected as consumption of fish, poultry, fruits, and vegetables declines from falling survival rates of different species of plants and animals due to increased salinity in the area and conversion of large tracts of lands for shrimp ponds. Such realities adversely impact women's health, nutrition, workload, and livelihood strategies. It has also been reported that there is migration of men out of shrimp-farming areas due to a reduction in adequate employment to sustain their families; female-headed households are thus on the rise (fieldwork observations 1999).

The case of shrimp aquaculture illustrates the breadth of gender concerns when a new form of production changes access to land, water, and employment. Specifically in relation to water, shrimp production has encroached upon common property access both to surface water and groundwater. As a result, access to water for drinking and bathing is constrained. Women's work in gaining access to water is thus increased, and the ability to sustain a range of livelihoods is reduced.

Conclusions

There is unlikely to be an easy transition anywhere in the global south from insufficient, differentiated, and insecure water access to the nearly universal, equitable, low-cost, and reliable access characteristic of the industrialized world. For the latter, the transition involved industrialization, the emergence of large-scale water utilities, and substantial interventions in the hydrological cycle. In Bangladesh, as in many parts of the global south, changes of this magnitude and character are not on the immediate horizon.

For the foreseeable future, small, low-cost changes are likely to be more viable than grand plans. Making such changes effectively will require understanding of the

social dimensions (who does the work, who makes the decisions, how change might exclude women and the poor) of different modes of water access. One lesson can be drawn from each of the three cases just described, and these three lessons may suggest modest ways of improving water access and hypotheses that could be investigated elsewhere.

In the first case, increased extraction of groundwater from agriculture has undermined recent improvements in access to drinking water. The lesson from this case is that groundwater conditions may hide conflict between two sectors, health and the economy, and between the work and interests of men and women. There may be simple ways of reducing these social conflicts. For example, drinking-water provision can sometimes be included in irrigation expansion. Lack of recognition of this type of social conflict, the relative social influence of the two sectors, health and the economy, and of the roles of men and women, could lead to declining health conditions and increasing work for women.

In the second case, improved drinking water access has been associated with mass arsenic poisoning. One lesson that can be drawn from this case is that our ignorance of natural diversity should not be underestimated (Wynne 1994). Those agencies promoting the use of hand pumps were unaware of the particular geological conditions, which compromised this solution to the problem of water-borne disease. As we write, in 2001, there is no agreement on how to avoid continued arsenic poisoning of many millions of people or provide viable alternative water options. We suggest that the effects of this poisoning will be greatest among the women of poor households.

In the third case, we described how the adoption of new forms of production, in this case shrimp culture, may encroach on common property access to water. Constrained access to water for drinking and bathing appears to affect the work of women more than that of men. At present, most of the literature on gender and water is addressed to government as the agency directing water projects. The lesson to be drawn from this third case is that social change that is not under the direction of government should also be subject to a gendered analysis.

Notes

1. These categories extend the analysis of Van Koppen (2000) and parallel the approach to command over food taken by Sen (1981).

2. Fieldwork observations, 1998, 1999. Fieldwork carried out by the second author in rural areas of Bangladesh in Dhaka, Tangail, and Khulna regions.

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