Water, power and gender: pressing questions and overlooked interests in a poor and crowded delta

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Water plays a pivotal role in economic activity, as a key input to agriculture and industry, and in human well-being. Access to clean drinking water has conferred many of the health benefits of the industrial world. Few natural resources play so central a role in both economic activities and in health. 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 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.

In this paper we examine some of the issues relating water and gender in the particular social and environmental conditions of Bangladesh. Bangladesh is a small, deltaic country with a large population (over 120 million), a low level of economic productivity (GNP/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. Similar issues also arise in many agrarian societies.

We start the paper with discussion of the various social uses of water and the ways in which those uses interact with gender and class relations. We raise general questions about interactions among water uses and gender relations, and we outline some of the specifics in the context of Bangladesh.

Then we turn to three pressing cases. The first two concern unforeseen conflicts and problems arising from the use of groundwater. In the first case, use of water for production has threatened drinking water supplies. The extension, over the last 30 years, of groundwater use to support Green Revolution agriculture has jeapordized the attempt to provide universal access to disease-free drinking water. Over-pumping for irrigation has lowered water levels leaving many drinking water handpumps dry for part of the year. Then, in the second case, this same process of lowering water tables is associated with large scale arsenic poisoning. In the last few years it has become apparent that arsenic naturally occurring in the ground is being released into the groundwater resulting in the arsenic poisoning of some 20 million people. These 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. There

is no happy ending to the story. 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.

There is a small but growing literature on gender and water (see particularly Cleaver (ed.) 1998), which is raising fascinating questions of broad significance for social science. This paper draws some key points from that literature and points toward some new directions for analysis. The literature has tended to focus upon the implications of gender analysis for governmental policy, especially development projects and water resources management, and for women s organization. In this paper we begin to sketch some questions which arise from a concern to understand the tripartite interaction of gender, water and power in the broader context of social change. There is, in other words, need to engage not only with male bias in development policy but also in the context of social change which is not initiated by government.

This paper raises three questions with the potential to extend the literature:

i. How do the boundaries between the economic and domestic spheres influence the use of water?

ii. What role does nature, specifically hydrological and geophysical conditions, play in social conflict?

iii. How can the analysis of water and gender relations be extended beyond a focus on development projects to look more widely at social change?

1 Gender, class and water

> 'Gender relations are the socially determined relations that differentiate male and female situations. People are born biologically female or male, but have to acquire a gender identity. Gender relations refer to the gender dimension of the social relations structuring the lives of individual men and women, such as the gender division of labour and the gender division of access to and control over resources.'
>
> Elson 1995: 1

In all societies, there are gender-based divisions of labor. In most, women do the bulk of domestic labor (Elson 1995: 259). This work includes a range of activities: the work of maintaining daily life (cooking, cleaning, washing clothes), managing the health of the household, caring for and raising the children. By contrast men dominate the economy. In most of the world, and certainly in South Asia, productive assets, that is, land, factories, and finance, are owned or controlled by men. From this gendered division of labor and property arises a division of interests in water between men and women. Stereotypically, women in rural households are concerned with drinking, cooking and washing water for

household use (the private domain), while the interests of men focus upon water for production, particularly irrigation water for agriculture (the public domain).

At the same time as there are divisions in the concerns of men and women with regard to water, the subordination of women is an almost universal phenomenon. Men, as a group, have more social and economic power than women do though the form and practice of that power varies considerably from one society to another. A prominent issue is the balance of priority between water for health (and the reproduction of the household), often a concern for women, and water for agricultural production, usually a concern for men.

Gender relations also interact with relations of social class. Access to and use of water are constrained by the material conditions and livelihoods of household members. For example, wealthier rural households in Bangladesh generally have access to drinking water from a well on their own land. Poorer households are more likely to use ponds, rivers or a communal well.

Borders and practices, agency and structure

One achievement of the 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 1995; Cleaver (ed) 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 Endeveld 1995; Jackson 1998) highlight the significance of this border for tackling a pressing analytical divide in the social sciences, brought to the fore by Giddens (Giddens 1976; Cassell 1993), between structure and agency. These two papers are interesting both for the theoretical suggestions they make and for the way they draw our attention to the central significance of the set of borders separating the home from the economy and the private from the public. We suggest that problematizing and exploring the social cleavages and intellectual dichotomies which cluster around the border between domestic and economic spheres may provide a broader illumination of the relationship between structure and agency. We also provide examples showing that an exploration ignoring natural conditions is sometimes perilous.

Zwarteveen and Endeveld 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 re-integration 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 Endeveld 1995)

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)

There are a series of real and conceptual divides that cluster around the borders between the domestic and economic spheres. These include borders between private and public domains, monetized and non-monetized exchange, productive and reproductive activities, family and enterprise. These divides are reflected in institutional structures, such as the division between government ministries of the economy and of health, and in intellectual partitions, such as those between the disciplines of economics and sociology. One important characteristic of these boundaries is that they act, individually and in concert, to reproduce patterns and continuity in social life.

In what ways are these borders involved in the separation of health and welfare from production and the relative priorities of the two spheres? Do divisions of influence, and ideas about social priorities, associated with these boundaries give men power over women, the economy priority over health, and irrigation precedence over drinking water? In the case studies below about changing water use in Bangladesh, we begin the process of exploring some aspects of power associated with borders.

2 Social uses of water

In this section, we describe the different uses of water and some of the ways in which gender and class relations may pattern them, particularly in the context of rural Bangladesh.

Drinking and cooking water and health

Improvements in hygiene, brought by the provision of clean water and sanitation, were the predominant reasons for the decline of water- and food-borne diseases in Nineteenth Century Britain (McKeown, 1979: 156, cited in Wilson, 1992: 46) and presumably in other industrialized countries.

Following this example, the expansion of access to groundwater in Bangladesh was heralded as the solution to the propagation, through rivers and ponds containing bacteria and other pathogens, of water-borne disease. Filtration through soils removes most bacteria from water. As Azad (1999) explains, the extension of rural access to groundwater, primarily through village hand pumps, was a pride of Bangladesh it brought 97% of the population under the coverage of safe drinking water . The United Nations Children s Fund (UNICEF) provided much of the impetus and financing for the drilling of rural tubewells (so called because they sink a solid tube down to the groundwater aquifer), and the delivery of handpumps to pump water to the surface. With donor, government and NGO support, as well as private installation, the number of tubewells in Bangladesh rose dramatically in the last two decades in Bangladesh to 4.5 million now.

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 goats. In rural areas, where there is no municipal supply of water, water is procured from diverse sources, including tubewells, ponds, canals, ditches, and rivers. Women use water from different sources depending on availability, proximity and purpose of use. Thus, the water supply system in rural Bangladesh is not a fixed system, but a set of water sources about which choices are made, often on a daily basis.

Drinking water is mainly obtained from tubewells (both deep and shallow), while surface water sources are used for other domestic purposes. Deep tubewells have been found to provide better quality water compared to shallow tubewells. These deep tubewells are more expensive, and are likely to be owned by richer households. Access to tubewells depends on whether it is privately owned or publicly owned.

Thus, access to and control over water is differentiated by class in rural Bangladesh; wealthier women have better access to cleaner water than poorer women (Shamim and Salahuddin, 1994). Access to water is also differentiated by location, since those households nearer a functioning tubewell are likely to use groundwater more often. However, any tubewell has to be shared among different users. It is common for private owners to restrict access to their tubewell or to charge a fee (although the latter is less common than the former). Tubewells 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 tubewells. But these are often broken or inadequately maintained, forcing many to depend on good relations with wealthier households (fieldwork observations, 1998).

Homestead ponds and canals are often the nearest source of water. But these sources are for aquaculture, washing clothes and utensils, bathing, washing domestic animals, and even a place to throw domestic waste. These multiple uses can all contribute to pollution of the surface water source, making it unfit for consumption. Water purification may be undertaken through filtering, boiling, and using water purifying tablets (made of alum), or through a range of indigenous purification strategies (Chadwick et al, 1998). The ability to purify surface water requires money and time and is thus generally restricted to more affluent households.

Nonetheless, proximity often 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 tubewell or surface water body to meet water needs. The distance to be covered can range from a few yards to over 100 yards. It has been observed that women and girls walk over several hours to fetch water each day (e.g. up to 2-5 hours each day) (Shamim and Salahuddin, 1994). Young girls are often responsible for getting water several times a day. This may constrain or prevent school attendance. In instances where a long walk is required to reach the nearest functioning tubewell, many families use closer polluted surface water.

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. If women use tubewell water for washing, usually in better off households, sometimes a makeshift enclosure of banana leaves is used**.** Not all households have closed latrines, and the poor are especially unlikely to have them. This makes it more difficult for women to maintain privacy in a conservative culture that emphasizes women s decorum.

Irrigation

Over the last thirty years, agricultural output in Bangladesh has increased dramatically. As a result of the Green Revolution, Bangladesh changed from being a large importer of foodgrains, in the 1970s and early 1980s, to national self-sufficiency in the late 1980s and the potential for limited exports in the near future. The Green Revolution is a set of new technologies and new practices in agriculture that combined nutrient-responsive seeds with industrial fertilizers, some elements of agricultural mechanization, 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 tubewells.

The rise of tubewells and water markets to distribute tubewell 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. Ownership of land often gives right to water flowing under, through or beside the land.

A number of initiatives have been made to introduce irrigation controlled by either poor people in general or, more specifically, by poor women. 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 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 water rights either, since the owner of the tubewell is the owner of the land on which it sits, and hence owns the water. 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 given a new productive asset, irrigation water, to those with land and pumps.

Planned irrigation projects in Bangladesh, as elsewhere, have overlooked non-monetized agriculture. Field observation suggests that almost all rural households have kitchen gardens which are worked and managed by women. There are few studies of kitchen gardens anywhere in the world. In Bangladesh, kitchen gardens are watered and probably 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, whereas fruit and vegetable production under the management of women do not have structured irrigation support.

Floods and flood control

Floods and flood control raise two different issues about gender and water. One is how flood crises affect women, their lives, their responsibilities and their property and position in a post-crisis household. The second is how new development projects intended to mitigate floods may reflect women s needs and change women s positions in society.

Women's work increases during social crises including those caused by flood. The collection of water, obtaining food, maintaining the home, all become more difficult. Rarely do men help in procuring water. Gender roles do not change during floods (Hanchett et al, 1998). Women are still responsible for all domestic duties, as well as looking after the young and the elderly and domestic animals. Female-headed

households are particularly hard-hit during floods. Women's property (personal belongings, jewelry and kitchen utensils) is the first to be sold during flood and food crises (Kabeer 1994). Reports show that women often sacrifice food and shelter to maintain poultry and goats, but these are sold off by their husbands in times of increasing hardship against women's will. Safety issues are especially important for women during times of prolonged floods, since flood shelters are often constructed in without separate facilities for women, and many reports of harassment and rape have come from flood shelters (fieldwork observations, Grameen Trust s website on Flood 98). Privacy in times of floods is also a major concern for women. Increased mortality during disaster disproportionately affects young girls, which suggests the effects of crisis are gendered.

Migration and dissolution of family unit during disasters often gives rise to female-headed households, which are more vulnerable. Women's personal assets, jewelry and kitchen implements consumed before the point of family breakdown, increasing women s hardship in survival and coping during and after natural disasters. Different ideologies of male and female property rights may mean that women's assets, including land, are disposed earlier in the downward cycle, so women have fewer resources to fall back on. 'Their only recourse is to sell their labor in the worst paid, highly casual and most subservient forms of income-earning activities' (Kabeer 1991: 259).

The second issue in relation to floods is the question of development projects. During the early 1990s, considerable foreign aid resources were invested in a Flood Action Plan for Bangladesh. Subsequently, some research was done on the gender consequences of this plan. For example, Hanchett et al (1998) studied the impact of floods on the livelihood strategies of women. Increasing large-scale flood control and water management schemes without attention to gender differences is likely to have negative impact on both social and ecological sustainability. It is important to acknowledge and address that the needs and roles of women are different from men in Bangladesh, as elsewhere, and that perceived benefits of water control do not include everyone. Participation of women in large-scale water projects has thus gained attention in the last few years in Bangladesh, but the male bias in these projects has not been changed.

Incorporating sensitivity to gender relations and gender interests in development projects raises profound questions about participation in the social order. The use of cheap female labor in the construction and maintenance of water structures may offer employment for some poor women, but it does not address broader questions about gender and class interests in water and the gendered consequences of crises.

3 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 both achievements were 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 tubewells has begun to lower water tables across the country (Sadeque 1996). Falling water tables have begun to threaten the advance of clean water. Some estimates suggest that between one third and one half of drinking water handpumps are now left dry for some parts of the year (Sadeque 1996).

Many electric- or diesel-powered irrigation tubewells can pump from deeper levels than handpumps can reach. Operating the lever of a handpump creates a partial vacuum at the top of the pipe which 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 which air pressure will sustain. By contrast, many of the larger, deep irrigation tubewells place a mechanical pump at the bottom of the well and can, therefore, pump water from much greater depths. Consequently, many shallow, handpump tubewells 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 tubewell 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

The story does not stop with this setback to the achievement of access to safe drinking water, because geophysical and hydrological conditions have complicated the picture further. 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 (SEMP, 1999). Arsenic has already affected 59 out of 64 districts in Bangladesh and 1 in 3 tubewells 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). Many deaths from arsenicosis have already been reported and the number of patients with arsenicosis is increasing, since arsenic poisoning takes usually 2-20 years to manifest itself.

One characteristic of this crisis is well documented. A large percentage of tubewells in Bangladesh bring up contaminated water. Further questions are less easily answered: Where does the arsenic originate? When did the contamination start? If recently, what happened to cause these silts to release their arsenic into the drinking water? What should be done?

There are two hypotheses about the geophysical circumstances that have led to arsenic contamination of groundwater. One suggests that arsenic is transformed into a form which is soluble in water when lower water levels expose arsenic-rich sediments to oxygen. This hypothesis connects the contamination to the lowering of water tables resulting from water extracted for irrigation as part of the Green Revolution. A second hypothesis suggests that arsenic is released when arsenic rich sediments react with organic materials also in the sediment:

> the arsenic derives from the reductive dissolution of arsenic-rich iron oxyhydroxides, which in turn are derived from weathering of base-metal sulphides Reduction is driven by concentrations of sedimentary organic matter of up to 6%.

(Nickson et al 1998).

This second hypothesis does not explain why widespread arsenic contamination has occurred only recently. Some arsenicosis patients are reported to have been sent for treatment in the mid-1980s, but clear measurements of drinking water contamination were not made until 1993 and 1994, and the scale of the poisoning was not apparent until 1996 (National Conference, 1999). The second hypothesis does suggest relatively simple solutions, which we explain below.

What is actually being done? Government and international agencies are taking some steps to identify contaminated tubewells, provide medical treatment for some, increase awareness and reduce mass panic. Wells are being tested and marked when they are found to contain unacceptable arsenic levels. A paper on the WHO website (Azad 1999) reports that 30,000 tubewells had been tested out of an estimated total of 4.5 million tubewells in Bangladesh. 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 handpumps, and face slow poisoning from arsenic. Families without alternative sources of drinking water continue to use arsenic-contaminated tubewell water, as one epidemiologist notes:

> During my visits to different arsenic-affected villages I have seen people drinking water from arsenic contaminated tube-wells, even after the health workers painted them red and advised them not to drink water from those. People simply do not stop drinking water from arsenic contaminated sources unless they have access to safe alternative options.
>
> (Milton 1999)

A series of questions and lessons are generated by this story. The most pressing question is, what is to be done to prevent the 20 to 70 million people at risk of arsenic poisoning becoming ill and dying from arsenicosis? Related to that question are others about causation and blame. Then there are more general lessons to be drawn for an understanding the social and natural conditions associated with this outcome.

Substantive discussions are taking place in Bangladesh, in national newspapers, universities, ngos and in government. There has also been discussion in global forums. Internet connections are facilitating the rapid global interchange of ideas. The Bangladesh government has been coordinating a national action plan to address arsenic poisoning. Nevertheless, the response to poisoning has been slow and incomplete (eg Milton 1999). And the delay of 2-20 years before symptoms are evident suggests that the scale of arsenicosis will not be known for several years.

At present the treatment of arsenic-contaminated water is not widely available and may be too expensive for most rural households. For many households struggling to survive, water purification or filtration is an added burden and use of scarce resources of money, fuel, time that they can ill afford. Many people thus continue to consume and use poisonous water despite the warnings and consequences due to a lack of alternatives available to them. Often, tubewells in the same village are contaminated to different extents, leading to heightened pressures on the ones that are producing water of low or no arsenic levels. There is some evidence that arsenic contamination may reduce with depth. A study of a large data base for West Bengal aquifers (Acharyya et al 1999: Figure 2) suggests that wells with a depth of 80-100m have lower, but still unacceptable levels of arsenic. Concerns remain about vertical percolation of arsenic-contaminated water from shallower aquifers.

Contamination may lead to greater conflict over uncontaminated water (i.e. the tubewells that are not marked red by government officials in the contaminated tubewell identification drive), and greater hardship for women procuring the water.

The gendered impacts of arsenic contamination of water are also becoming evident in other areas of their 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, November 10, 1998). Mass panic and superstitious fears may increase the ostracization of women in arsenic contaminated areas. For example, there is fear that arsenicosis may be contagious (FEJB, 1999). All this points to the serious social consequences of groundwater poisoning for women in Bangladesh.

Since arsenicosis does not have a definite cure and takes a long time to manifest itself, it is easily misdiagnosed. If detected early, the effects can be retarded by consuming arsenic-free water and high quantities of fruits and vegetables. Again, such options are more limited for women in Bangladesh, where nutritional intake is skewed in favor of men, with poor people already at a disadvantage in general.

The second hypothesis about the geophysical conditions releasing arsenic into the water suggests two ideas about what should be done. First, simple technologies at household-level might allow arsenic contaminated water to be purified. If the diagnosis that contamination comes from reductive dissolution of iron oxyhydroxides proves correct, then allowing water to stand in the presence of oxygen may cause arsenic to be precipitated as a deposit.

> as dissolved iron is oxidized it precipitates as iron oxyhydroxide, which scavenges arsenic from solution. It follows that simple aeration of anoxic Bangladesh groundwater, followed by settling should remove a considerable amount of arsenic from solution.
>
> (Nickson et al 1998)

Then clean water could be separated from the arsenic rich sediment left at the bottom of the jar. Arsenic contamination of the water would be reduced. Disposal of the arsenic-rich sediment would remain problematic but less so than poisoned drinking water. Neither confirmation of this recommendation nor an examination of the practical implementation of household treatment has yet been reported (see lists of arsenic papers in Dainichi Consult 1999 and Arsenic Crisis Information Center 1999).

A second suggestion arising from an understanding of the soil and water conditions concerns future placing of tubewells:

> it should now be possible, by sedimentological study of the Ganges alluvial sediments , to guide the placement of new water wells so they will be free of arsenic.
>
> (Nickson et al 1998: 338)

The two alternative hypotheses about how arsenic is released into the groundwater are blurred further by an additional possibility, that arsenic is being absorbed in the food chain, and also by questions of who or what is to be blamed. No studies have so far been reported which substantiate the idea that fish and rice are absorbing arsenic (see list of arsenic-related publications maintained on Dainichi Consult website). If this additional possibility is correct, however, response to the problem is going to be even more difficult.

The question of blame may be important because it could focus resources in more or less useful directions. Two entities are currently being blamed for the arsenic crisis: India and Unicef.

The argument against India rests on the role of water diversions from the Ganges at the Farakka Barrage, just upstream of the border with Bangladesh. These diversions were intended to improve navigation to Calcutta Port and reduce salinity of the water supply for the city of Calcutta. The reduction of Ganges flow, resulting from the diversion, and its repercussions in Bangladesh have been a cause of conflict between India and Bangladesh for at least four decades (Crow et al 1995).

In the context of arsenic contamination, the diversions at Farakka are blamed as the cause of reduced levels of groundwater. One map of the geographic distribution of arsenic poisoning in Bangladesh (Dainichi Consult 1999) does show arsenic contamination higher in the West and South West of Bangladesh. In these areas, a reduced seasonal flow in the Ganges might have led to lower water tables. The spatial distribution of contamination, in other words, does not appear wholly incompatible with this thesis. A simpler alternative view, however, is that the map reflects the underlying distribution of arsenic rich minerals and their subsequent dispersal through erosion. This would suggest that the source of the arsenic rich sediments lies in the Ganges basin upstream of Bangladesh (Nickson, et al, 1998). Then it is the geology of the region, rather than contemporary action by the Indian government, which is to blame.

A second agency blamed for the crisis is Unicef, the United Nations Children s Fund. A class action law suit is being prepared seeking compensation from Unicef on behalf of the millions of unsuspecting victims of arsenic poisoning who are slowly dying in Bangladesh (*South China Morning Post*, quoted in Milton 1999. See also *Developments* 1999: 20). Unicef promoted and installed many thousands of drinking water tubewells throughout Bangladesh. It is suggested that Unicef should have tested the water for arsenic contamination which had been reported in the 1980s in West Bengal. It is certainly ironic that the agency most obviously concerned with health should have played so prominent a role in developing access to drinking water that has turned out to be contaminated. But it is not clear that legal action will illuminate what should be done, direct financial resources to support that action, or compensate those suffering arsenicosis.

In a time of crisis, however, the search for someone to blame is seductive, as this quote from a report by environmental journalists illustrates:

> "Many people in the past had warned the proponents of the Green Revolution about the dangers of over-exploitation of groundwater for irrigation. But the policymakers in the 1960s did not pay heed to such warnings. By drilling hundreds of thousands of tubewells – both of irrigation and safe drinking water in the villages – experts now say, the authorities and planners had unwittingly exposed millions of the rural Bangladeshis to the naturally occurring poisons in the groundwater."
>
> (FEJB, 1999)

One important question arises from these two crises over groundwater. Did social priorities embedded in the various borders between productive and reproductive activities reduce sensitivity to the consequences of groundwater use? The influence of priorities given to health and production in the concerns of government, international agencies and the news media would be worth investigation. In both crises, productive use of water for irrigation seems to be associated with a deterioration in drinking water access.

4 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 some 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 South West have been turned into saline ponds where shrimp are cultured, and increasing numbers of people are involved in the industry.

In many areas, land is forcibly taken by richer farmers from poorer people for shrimp farms, and often these shrimp farm owner are from outside the area (Khatoon 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 Sunderban 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; Khatoon, 1995). As more and more families are involved in contracting out family labor for the shrimp farms, increasing numbers of women and children are becoming shrimp collectors and shrimp processors (Datta, 1995). This is being heralded as employment generation by the industry (Khatoon 1995). But the impacts of the industry on the lives and livelihoods of rural women are not considered.

Shrimp ponds, which require saline water, are made by constructing canals which 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 by shrimp ponds. Use of tubewells in coastal areas is not common, since the groundwater is salty. Many people use pond water or rainwater in the monsoon season. But in the dry season, it is difficult for women to procure potable 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, have to walk considerable distances (often over 2-5 km) to get drinking water. 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, etc.). They now spend most of the day in rivers and creeks to collect shrimp fry, often standing in waist-deep water, that 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 appear to have had a greater impact on women in than men coastal areas (Lopez-Rodriguez, 1996; Datta, 1995). A decline in nutritional diversity is suspected as consumption of fish, poultry, fruits and vegetable decline 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.

The case of shrimp aquaculture illustrates the breadth of gender concerns when a new form of enterprise changes access to land, water and employment. In this case, peasant household enterprises using family labor to produce both for consumption and sale are being transformed into market-oriented farms using hired labor. The separation of family and firm to which this leads is associated with wide-ranging changes in social organization with implications for both class and gender relations.

5 Conclusions

These brief case studies raise more questions than answers. We started the paper with three questions and we use those to structure our conclusions.

How do the boundaries between the economic and domestic spheres influence the use of water? We have suggested that the divisions clustering around these boundaries may have delayed understanding and reduced the priority of response to the two groundwater crises, one in which falling water tables caused handpumps to go dry, and one in which arsenic contaminated the drinking water. A much fuller study of the complex causation of these crises will be required to substantiate this suggestion. We nevertheless draw attention to two aspects of the crises in relation to the boundary between economic and domestic spheres. Firstly, in both groundwater crises health seems to have been given lower priority than production. Secondly, the division of responsibilities between government bureaux and academic disciplines, both of which mirror the borders between reproductive and productive activities, hampers a complete understanding of the relation between natural and social worlds.

What role does nature, specifically hydrological and geophysical conditions, play in social conflict and social change? These case studies illuminate three aspects of the relationship between the social and natural worlds. Firstly, the case studies show how hydrological conditions may connect different social uses of water and in the process disguise social conflict. Changes in groundwater levels connect productive uses of water to uses for drinking water. That link creates a tension between social priorities for growth and well-being and between male and female domains. There is no direct conflict between government bureaux concerned with growth and those concerned with health.

Nor is there any direct conflict between men and women. These are conflicts mediated by groundwater conditions. Similarly in the case of shrimp aquaculture, there may be little direct conflict between shrimp entrepreneurs and poor women, except perhaps over wages and conditions of employment in shrimp farming. The wider implications of this social change for water use and family well-being are mediated, or concealed, by changes in pond, land and groundwater conditions. Social conflicts are being mediated by the natural terrain in which they are situated.

Secondly, these case studies illustrate the need to recognize the incomplete character of our knowledge of the physical world (Wynne 1994). Scientists in Bangladesh and globally are now scrambling to understand and deal with a case of poisoning on a scale and with a nature completely unforeseen by both environmental prophesy and fiction-writing alike. And the other two cases we describe may deserve a similar global response. But in the absence of simple and shocking disaster they are unlikely to be accorded any such attention.

How can the analysis of gender and water be extended beyond a focus on development projects to look more widely at social change? This question is simpler than it sounds. At present most of the literature on gender and water is addressed to government as the agency directing development projects which involve water use. Sometimes the audience is extended to include international and nongovernmental organizations promoting development projects. Several papers (Cleaver and Elson 1995; Van Wijk et al 1996; Zwarteveen 1998) make specific recommendations about gender awareness in water resource management. This focus is not surprising nor inappropriate. Most research on women and gender is funded by governmental or development agencies and every effort should be made to challenge the gender biases which have dominated development projects.

One simple point illustrated by all three case studies is that the analysis of gender and water also raises important questions in the context of social change that is not directed by government. The dissemination of privately owned irrigation tubewells provoked the conflict between water for agriculture and water for drinking. This is a social change that was encouraged by government subsidies for pumps, but it was not a development project directly controlled by any development agency, governmental or otherwise. The attention and funds of the water ministry in Bangladesh, for example, were focused on large canal irrigation schemes with a more limited reach. Throughout South Asia, the rapid expansion of irrigation by wells tapping groundwater has been the private project of peasant households, led by the more affluent peasants and largely confined to those owning land. The corollary of this point is that the analysis of gender and water needs to be applied more broadly to non-directed processes of social change as well as to development projects.

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