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Water Policy Program

Water Policy Research

HIGHLIGHT

Safe Water and Nutritional Improvements

Opportunities for Long Term Health Advancements

Safe water and good Nutritious diet are pillars of good health. Susceptibility to various diseases increases when either of these is compromised. Access to safe water and nutritious diet is also linked with social factors such as poverty, hence many of these diseases have a strong aspect of being highly socially determined.

Possibly, a great health burden of the poor can be addressed in a preventive manner by just addressing these two pillars. When we look at diseases such as fluorosis, Arsenicosis, Diarrhea, Renal stones, they seem to relate to Anemia, Osteoporosis, infant mortality, some types of heart diseases and other concerns on which there is wider action in terms of public health. To be noted is that focusing on either one – water or nutrition - is limiting. In some cases, certain water-based nutrients increase resistance to diseases. Also, vulnerability to these diseases is specific in terms of gender, age and certain life-phases as pregnancy and early childhood.

The discussion brings us to two main action points: access to safe water in nutrition and food programmes through targeted water filters and developing preservation of local nutritious food to be consumed locally. These two interventions can go a long way as a first step in addressing these problems. The arguments put forward in this paper strengthen the belief that much can be gained in terms of long term health advancements by safe water and nutritional improvements. They can become good opportunities to break deep-set health inequities.

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Safe Water and Nutritional Improvements Opportunities for Long Term Health Advancements[1]

Research highlight based on Iyengar 2012; Krishnan, S. and Indu 2012; Reddy 2012; Sapur 2012[2]

Introduction

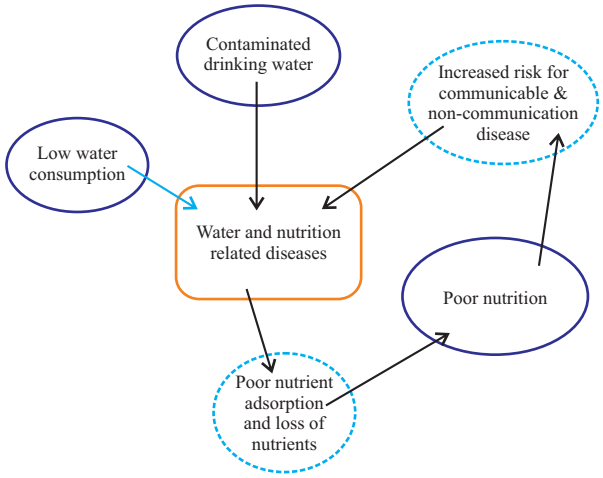
The cycle of perpetual degradation in which poverty along with heavy manual labor, combines with poor food and nutrition to drag down people is daunting. As one factor feeds another, we find that malnutrition does not allow people to reach higher forms of human endeavor. On the other hand, being stuck in a permanent state of lower labor economy and insecurity therein, stagnates people within the same state. When other related factors creep in such as lack of access to good health care facilities, awareness of such health care, access to safer drinking water and sanitation facilities, this cycle further accentuates. The twin dangers of unsafe water and malnutrition further drive down the health status and create wider health problems that we are now finding difficult to manage. Especially since many of these water-related diseases are aggravated by certain malnutrition conditions which are more prevalent among the poor, these diseases too have a typical epidemiology that is characterized by higher intensity in the poorer regions of the country. All these make such diseases more difficult to handle, especially since there is also very poor awareness of health and access to good health care. In some sense, these diseases have a very strong social determinant to them, therefore making it difficult to fix them just with technological approaches (Anand et al. 2004).

Taking the above as symptomatic of a larger problem, here we outline some of these diseases and manners in which water and nutrition problems interact. When we understand the nature of these problems, they also offer us possibly common approaches to address the problems at many levels. It also gives us various handles to tackle the same problem and experiences cutting across sectors that might be helpful.

Under a general concept of water and nutrition related problems, we see from Figure 1 that, a combination of factors including low water consumption, unsafe quality of water and deficient nutrition lead to a certain set of diseases. With the onset of these diseases, due to the nature of contaminants, there is lesser absorption within the body of certain nutrients and also their loss from the body. This further increases malnutrition and aggravates the disease.

Within this cycle, multiple diseases find a host and affected people find it difficult to escape from this self-perpetuating chain. It makes communities more vulnerable to these diseases and solutions turn difficult. The important questions here being: Are there ways to get out of this loop and go towards some solutions? Are there ways in which the complexity of the problem can be kept in mind and approaches developed to address them?

Figure 1 Self-perpetuating chain of Water, Nutrition related Health problems



[1]This IWMI-Tata Highlight is based on research carried out with support from the International Water Management Institute (IWMI), Colombo. This is not externally peer-reviewed and the views expressed are of the author/s alone and not of IWMI or its funding partners.

[2]This paper is available on request from p.reghu@cgiar.org

Understanding the linkages

Table 1 summarizes some of the statistics related to water quality problems in India. It must be noted, however, that this summary is based on poor nation-wide data and represents only the tip of the iceberg. The reality could be much grimmer than what is presented here (Krishnan 2010). Relating this widespread disease burden with the large nutrient deficit facing the country (HUNGaMa 2011), the combined impact of these two put together is enormous. When combined, these two could also be a major significant chunk of the overall health burden of the country, especially among the poorest. If we just take the aspect of preventive health, then safe water and nutrition are the two prime pillars. They together present a great opportunity to tackle in a preventive manner a large number of diseases and help partly in pulling the poor out of the health-poverty link.

Table 1 The extent and impact of Drinking Water Quality problems in India

Quality problems	No. of affected districts	Population affected/ exposed	Causes	Impacts
Salinity	137	No estimates available	Inherent(geogenic)/Man made (eg. coastal saline intrusion due to over-pumping)	Kidney stones due to poor hydration in such areas (Rs.7500 cost per family per year)
Fluoride	203	65 million	Inherent (geogenic), but aggravated also by over-exploitation; increased by malnutrition	Fluorosis; DALY = 38.5 per 1000 population; > Rs. 5000 per capita annual expenses
Arsenic	35	5 million in WB; more in Assam, Bihar	Complex geogenic processes not yet well understood; but suspected to be related to excessive use and related water table fluctuations; increased by malnutrition	Arsenicosis ; DALY 5-27 per 1000 population
Iron	206	No good estimates	Geogenic mainly	Iron overload; Cirrhosis; suspected Diarrhoel linkages; Cardiac linkages
Biological	No good estimates	No good estimates	Related to poor sanitation and hygiene practices; increased by malnutrition	Diarrheal problems; DALY > 22 million years annually; total 4.5 lakh[3] deaths annually
Agrochemicals	No good estimates	No good estimates	Related to pesticide/fertilizer use in agriculture	Multiple impacts; not understood well
Industrial effluents	No good estimates	No good estimates	Due to effluents from Industries	Multiple impacts; not understood well

Fluorosis: Tackling Osteoporosis, Anemia, Thyroid imbalance

Fluorosis is primarily caused by consumption of drinking water, mainly from wells that have high fluoride. Around 10 states of the country have very high endemicity, but cases are reported from 24 states of India. At last report, the population exposed to high fluoride is 65 million (Susheela 2011), but current figures could be higher than these 1999 figures.

The linkage of fluoride with nutrition comes from the fact that there are numerous interactions of fluoride within the body causing various nutrition-related disorders. Also, some nutrients have the capacity to flush or partly detoxify fluoride from the body. This is especially important since the entry of fluoride through food has become high in endemic areas (Reddy and Deme 2010).

[3]One lakh = 0.1 million

The aspect of Fluoride which is highly reactive and causes several disruptions within the body also comes to advantage with the fact that in fluoride-endemic areas, one can achieve improvements in many other problems by just reducing the entry of fluoride into the body.

Perhaps of greatest benefit by reducing intake of fluoride is in reducing anemia for pregnant women and thereby reducing infant and maternal mortality and morbidity due to anemia. This is of value even to any other Anemia that is induced by Fluoride. The linkage here is with the Mucosa membrane in the small intestine which gets periodically destroyed due to fluoride. It has been shown that Hemoglobin levels significantly improve even with short term stoppage of fluoride entry into the body. The impact of Iron supplementsbecomes more prominent in such cases (Susheela 2011).

The action of fluoride on the Thyroid gland is complex and less properly understood. However, vast literature and observations exist of imbalances resulting in hypo and hyper thyroidal conditions causing imbalances in the Thyroidal action. This also increases the Iodine deficiency disorders (IDD) thereby reducing the effect of Iodine supplementation and causing greater Thyroidal problems in people with already existing Iodine deficiency. One can therefore visualize a fluoride reduction program as helping in IDD and thyroidal problems too.

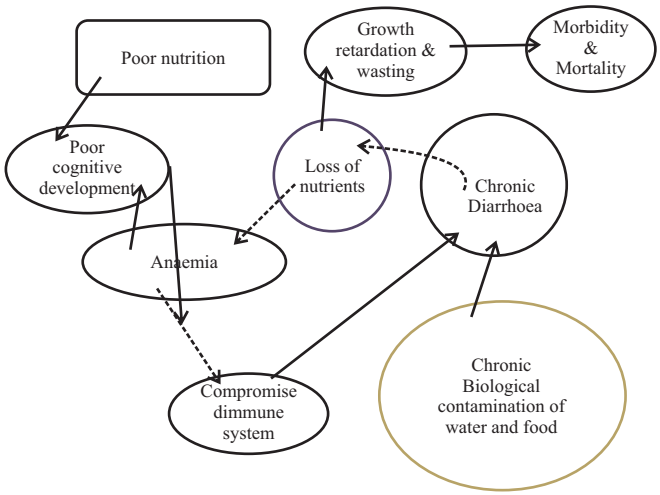
The most severe effect of fluoride action is on bones. Fluoride when directly interacting with Calcium in bones forms Fluoroapatite. But in children who are highly affected, it also causes Osteoporosis, especially in the long bones. This type of juvenile Osteoporosis is rare in general, but found in places with severe Calcium deficiency and high Fluoride consumption. Addressing such type of Osteoporosis requires strong action on fluoride, but also Calcium supplementation and other nutrients that can help in better Calcium absorption (Reddy and Deme 2010).

Other key nutrients important in fighting fluorosis are Magnesium and Vitamin C (helpful in reducing fluoride toxicity in body and removal to some extent). Some of the important food items that can be suggested for addressing fluorosis and related problems are Milk, Eggs, *Amla*, Green Leaves, *Til* (Sesame), *Gur* (Jaggery), Soya and area-specific items such as *Moringa* (pod and leaves), Cassia Tora leaves, broken wheat (*Dahlia*).

There are a wide range of interventions that are possible to address fluorosis and related diseases and this area is ripe for wide experimentation. Till now the problem of supply of safe water itself has not stabilized with numerous ideas being tested for past many decades. Water treatment has been tried widely at the community and domestic level. Some of the recent efforts at community level treatment have sustained, but the acceptance of domestic filters have not sustained on a wide basis for long periods. Otherwise, rainwater harvesting and water based services are being attempted widely. In terms of nutrition based measures to address fluorosis, mainly the efforts have been quite localized at clinics or small experiments in the field. Very few field programs are in place, and there is need for larger level testing of ideas.

Child Diarrhea with Zinc based treatment

Figure 2 Linkage between repeated Diarrhea, loss of nutrients and Anemia (NAP, 1992)



The dynamic relationship between infant mortality and fertility rate is at the heart of the so-called demographic transition (Yamada 1984). Acute respiratory mal-function? and diarrhea are the main causes of infant mortality in India (Anand et al. 2000).Diarrhoel (overall DALY > 22 million years annually in India and 4.25 lakh deaths due to Diarrhea annually in India (NICED 2004). When we look at global trends, then South Asia's and Indian situation appears stark in terms of child mortality and diarrheal diseases being one of the important causes (Black et al. 2008; Liu et al, 2012).

One effective way to tackle the massive health burden of child diarrhea is by Zinc supplementation alongwith ORS. Trials show that especially in population having deficiency of Zinc in diet, the effectiveness of such supplementation with Zinc of 20 mg/day for 20 days along with ORS is very high. Currently, even the practice of ORS is not well known. Repeated episodes of Child Diarrhea result in heavy nutrient loss and area major cause of child malnutrition. It is also the major cause of child mortality under 5 years of age (NAP 1992).

The experience of Zinc supplementation in India, however, has not been very encouraging till now. There is a problem of supply of supplements in terms of production facilities and also systems of supply for making the supplements available. Also, in terms of information campaigns, it has not yet permeated widely into public health practice (Gitanjali and Weerasuriya 2011). The awareness programs do not emphasizeenough about the dietary guidelines during diarrhea which may lead to chronic malnutrition especially in children.

Child Diarrhea also introduces a cyclic linkage with repeated incidence resulting in constant loss of essential nutrients, further compromising the immune system and making children more vulnerable to the diseases (see Figure 2). Breaking out this cycle requires a multi-pronged approach, not only from safe water and nutrition, but also in sanitation and hygiene. Since child diarrhea is at the crux of morbidity and mortality in rural area, much is to be gained from such a combined outlook.

Arsenicososis: safe water and early lessons in nutrition linkages

Though the linkages between Arsenic release and increasing groundwater exploitation is not fully clear, some phenomena such as increasing pre-monsoon depth of water table and rise in use of chemical fertilizers enable more Arsenic to be released. Some estimates are of 5 million people exposed to high Arsenic in West Bengal alone (WHO 2002). Consequently, we see more areas starting from West Bengal and now much parts of Ganges plains that report high Arsenic in groundwater. However, the intriguing question is that Arsenicosis is not that widespread in all these areas. One angle that is being explored is that of possible dietary changes regionally which provide more resistance to Arsenic action within the body.

The linkage of preventing adverse Arsenicosis through targeted nutritious diet is a relatively nascent area. It is a fertile area forresearch in which different theories are being proposed. On one hand, there have been efforts to explore the Selenium-Arsenic angle. Since Arsenic has been used to address Selenium poisoning since the 1930s, this direction of using Selenium to target Arsenic is being explored now. The results till now are not conclusive though.

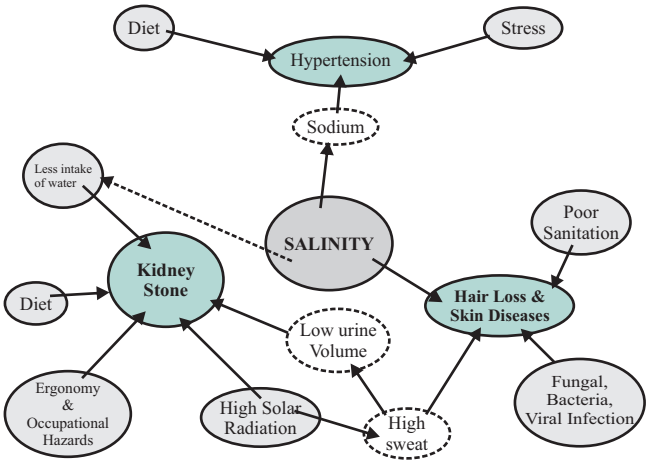
Another direction is that of Vitamin (A, C and E) antioxidants which can increase reactive oxygen species and provide some protection to Arsenic toxicity. Several flavanoids are being studied for their role in this process too. One possibility being proposed is to promote easily available Spinach which contains many of thenutrients that can help fight Arsenic (Mondal et al. 2001).

Renal Stones: Water and dietary possibilities

Various studies on Renal stone epidemiology and etiology do not establish any definite connection between water quality problems and prevalence of renal stones. However, the fact remains that poor water intake leading to low hydration of the kidneys over long time is a major factor in Renal stone occurrence. A low urine volume due to low hydration is by far the most common abnormality noted in metabolic evolution of kidney stones. This has an indirect connection with water quality, especially in saline water areas where people tend to consume less quantity of water due to aesthetic reasons of taste, feeling heaviness, etc. Epidemiological studies in India and worldwide point to higher incidences of Renal stone cases in areas with warmer climate, where water scarcity is more and loss of water with sweating adds to the hydraulic stress in kidneys. Overall, greater water intake can prevent Renal stones to some extant (Indu et al. 2010). Calcium stones are the most common renal stones like calcium oxalate, calcium phosphates and uric acid stones. Due to this, for decades low calcium diets were recommended to reduce the risk for renal stones, however chronic prolonged calcium restriction may damage the bones and lead to osteoporosis. Calcium restriction does not prevent stone formation and may cause or worsen osteoporosis (Martini

2002). To reduce the oxalate absorption, it is advised to consume high calcium food(150mg of calcium to bind100 mg of oxalates) at the same time in the meal (Meschi et al. 2004).

Figure 3 Causal factors linking Water salinity



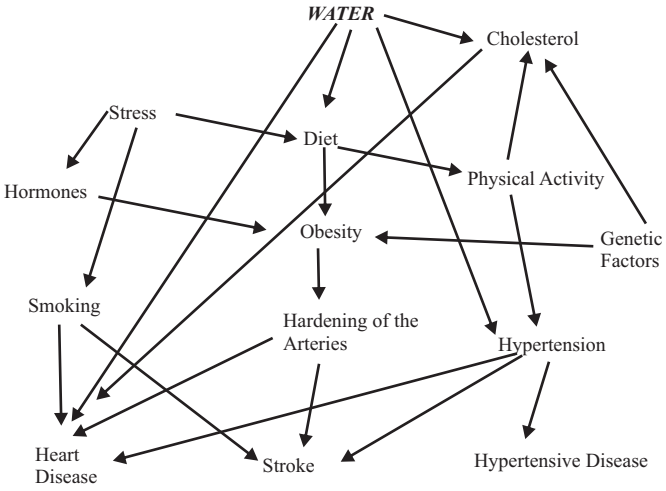
However, dietary intake is also important for Renal stone, in many places, more than the water aspect too (see Figure 3).

Nutrition intake from natural local water

Though the total nutrient intake from drinking water might be quite low as compared with recommended dietary intake, for populations with highly deficient nutrition, such intake could be significant. The bioavailability of nutrients from water depends on their form of existence. The most well established linkage of the contribution of drinking water in terms of beneficial nutrients has been that of hard water i.e Calcium and Magnesium salts. Especially the long term consumption of highly bioavailable Magnesium from hard water has been related by many studies to lower incidences of acute cardio-vascular disease. This might also be because required Magnesium is not being met from regular diet. In such case, it makes less sense to completely demineralize drinking water and remove essential salts from it (WHO 2005).

Further, low mineralized water has been found to be highly reactive and possibly corrosive of metals in contact with water. In that sense, the entry of toxic metals into drinking water increases. The other problem of low mineralized water is that it has a negative effect on homeostasis mechanisms of the body. This results in release of sodium, potassium, chloride, calcium and magnesium ions from the body.

Figure 4 Etiology for Cardiovascular diseases (from WHO, 2005)



Antioxidants to tackle contaminants

The role of Vitamins and antioxidants in providing resistance to contaminants from food and drinking water is of wide interest today. Especially the role of Vitamin C in fruits such as Amla is highly beneficial. The oxidative stress created by contaminants in the body and the free radicals generated need to be scavenged for and absorbed. These Vitamins and antioxidants play a crucial role in such scavenging and preventing toxic action of contaminants to an extent. Therefore, instead of adopting a contaminant and disease specific approach, antioxidants have the ability to provide relief to range of contaminants including fluoride and arsenic, as has been documented.

Flavanoids or color pigments in plants are highly effective as antioxidants. Also they play an important role of increasing the effectiveness of Vitamin C. In combination, Flavanoids and Vitamin C help to make each other more effective. Citrus fruits, dry beans, skins of fruits, green tea, spinach and cocoa are sources of flavanoids. Fruits such as pomegranates, green leafy vegetables such as spinach and onions are good sources of antioxidants.

Nutritional and Safe Water Benefits for Widespread Diseases: Typhoid, Jaundice, TB

The role of safe water and nutrition is relevant to many widespread diseases. Tuberculosis (TB) morbidity and mortality is highly linked with malnutrition. Unsafe water increases the burden of infection with other diseases. Water-borne diseases include Typhoid, Jaundice and Cholera.

Together, better drinking water and nutrition can play a strong role in prevention and curative aspects of many diseases.

Compounded benefits from combined interventions in Safe Water and Nutrition

The above discussion puts together some of the known and documented interactions of safe water and nutrition towards better health. As far as any practice goes in today's context, be it that of water supply, or food & nutrition programs, there is rarely an emphasis on a combined approach in bringing forward both these aspects together.

There is a lot of advantage in brining safe water and nutrition concepts together. In some cases, one of these acts in a preventive manner whereas the other acts more towards curative aspects. This increases the acceptance of either of them for the community, which would otherwise not been as receptive to a single approach.

Above this is also an element of compounding effect with such combination. By compounding what is meant here is that the combined effect of safe water and nutrition is much more than each of them taking individually. This is true for many water related diseases such as fluorosis in which some of the symptoms related to Calcium deficiency and bone degeneration would not heal quickly with just supply of safe water. In that case, Calcium supplementation will help in quicker healing of those symptoms, which in turn increases the acceptability of safe water solutions such as a domestic water filter.

Some strategies to address safe water and nutrition

A myriad of different interventions can be directed to address the problems described in this paper. Here we choose to focus specifically on two key ideas which we feel can have maximum impact and are practically feasible to test first and then implement on a large scale.

Safe Water: Filters at nutrition and food provider locations

To bring the concept of safe water into work on health and improved nutrition, this thinking needs to be imbibed within all programmes concerning these sectors. Rural nutrition is being enabled through various efforts – mid-day meals, Anganwadi, special programmes for pregnant and lactating mothers, etc. We can add to this list, schools, and also local health clinics including CHCs, PHCs and sub-clinics. However, the aspect of safe water in local context is missed in any of these. To get safe water options within such programmes however, can be difficult in the face of dependence on public water supply systems which suffer from quality issues. Therefore specific improvement in the form of filters would be needed for these programmes. Specifically, it is crucial to make sure that *infants and children under 5 are ensured safe water* free from contamination since they are affected most with even very low contaminant loading.

Ensuring this would require water filters that can make safe water available at any of these food and nutrition enhancement providers. Some of these filters have already been developed catering to local requirement such as those for fluoride removal based on activated alumina. There is need for effort to develop more such low cost, low energy requirement and low maintenance water filters useful to improve local water and make it safer for consumption.

Nutrition: Preservation of local nutritious food, especially green leafy material

Apart from any larger scale fortification and supplementation, what can really sustain in longer periods and especially under stress situations such as climatic extremes and situations of economic and security problems is the satisfaction of nutritional requirements with local available food. All across the country, many local foods are consumed in specific seasons throughout the year. Most of these nutritious foods are dwindling in consumption. Examples are Cassia Tora, Purslane (Luni Bhaji in Hindi), Moringa, Amla, etc which have very high nutrition content. Also, other useful food items such as wheat grass, and leaves of plants such as of *Chana* go waste. Simple interventions aiming at food preservation, especially of leafy material, can go a long way in creating local nutrition security aimed at micro-nutrients such as calcium, Iron and vitamins along with proteins available in such leaves. Localized food preservation units can be based on quite basic technology needing only solar based drying methods. In order to make these processes more efficient, technologies that enable hot air drying can also

be used, but they can result in more nutrient loss. Being able to preserve can create flexibility in good consumption and extend nutrition availability to the entire year. Traditionally, food preservation is already done by communities. However, modern food processing and preservation is quite inaccessible and expensive, thereby excluding the poor. Instead, if there are interventions aiming at improving local food preservation techniques and providing storage, a lot of good nutritious food can be preserved for longer periods. There can also be centralized local facilities for food preservation operated by NGOs providing services just as local *Chakkis* (flour mills).

Apart from leaves, fruits such as Amla and vegetables can also be preserved by solar or shade drying process.

The food preserved from such localized sources can be then be utilized whether individually by families, or in groups for specific programmes such as for mid-day meal, Anganwadi, etc. and also probably have commercial value creating self-employment in the future.

These two directions – a) water filters specific to local requirements, and b), preservation of local nutritious food, - are two focused activities that can reap rich dividends in addressing the combined problems of safe water and nutrition towards better health.

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About the IWMI-Tata Program and Water Policy Highlights

The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

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