Water
Churches Together in Cumbria Environment Group
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The individual's perception of the "state of health" of static or running water is based on what can be seen on that particular stretch of water. Are kingfishers present, are there fish and mammals and is there a healthy development of plant life? Indeed it is no surprise that so many of the water companies, when they were responsible for freshwater quality, used the kingfisher on the front cover of their annual reports. There are, of course, less visible indicators of water quality, most notably the invertebrate community, the composition of which provides a most sensitive index of the health of a freshwater system. Even less visible is the microbial community that plays a key role in the cycling of nutrients. In both lake and river systems the populations that might be expected are: algae – 10^3 to 10^4 per ml, bacteria – 10^6 to 10^7 per ml, and viruses – 10^8 to 10^9 per ml. These organisms also respond to various forms of pollution in a manner that may result in further decline in water quality e.g. toxin production, acidification and catastrophic loss of oxygen.

Despite the fact that the UK is a 'water stressed' nation, Cumbria is well endowed with water, thanks to its mountainous regions and the lakes that formed after the retreat of the glaciers. Even in this area, this does not mean that we do not encounter problems of water supply and water quality. The purpose of this paper is to examine these problems as they affect us in our homes, our county, our country and internationally.

Water – Some basic information

- Less than 1% of the world's fresh water is available for human use (the rest is in the ice caps and glaciers). *Not all of the available fresh water is fit for use or consumption, and the water in the polar ice caps and glaciers is diminishing as a result of climate change.*
- 66% of the human body is water.
- Humans can survive without food for more than 30 days but for less than 7 days without water (a camel can last for 17 days).
- We use 65 litres (l.) each time we use the washing machine; 25 l. when we use the dishwasher.
- The average human requires 2.5-4.0 litre a day to survive, yet in the UK we use 150 litres a day (compare this with water stressed Las Vegas where the consumption is 1500 litres a day).
- If everyone in the UK took a shower (not a power shower) instead of a bath we could save, collectively, as much water in a week as it would take to fill Wembley Stadium ten times.
- If everyone in the UK turned off the tap when they were brushing their teeth, we would save as much water in a week as it would take to fill the Millennium Dome.
- If we used water butts rather than a garden hose, then we would save enough water to supply a family of four for two days.

Water in the home

Although we have a plentiful supply of water locally, especially in Cumbria, this does not mean that we should not take steps to reduce our consumption. For many households the implementation of water metering can save on costs as well as providing us with a direct measure of how much we are consuming. Savings can be made if we install water butts to prevent excess run-off entering the sewerage system, water hippos, and allow roof run off to flow into soak aways. In our homes we can help by ensuring that we don't leave taps running unnecessarily and attending promptly to dripping taps. A shower is more economical than a bath. In our gardens we can question whether the use of the hose or the sprinkler is really necessary. Even in Cumbria, we can find areas of our gardens that are susceptible to drought. *Gardening Which* produces three excellent leaflets entitled "The Water Conscious Gardener" covering the topics "Planning a Water-Saving Garden", "Coping with Drought" and "Drought-Resistant Plants". These publications are supported by all water-supply companies and

can be obtained from North West Water or direct from *Gardening Which*, PO Box 44, Hertford X, SG14 1SH.

Water in Industry

The greatest demand for water in Britain comes from industry. For example, the demands of the following industrial processes are:

- 1 litre of petrol requires 7 – 34 litres of water.
- 1 can of vegetables requires 40 litres of water.
- 1 tonne of coal requires 1,400 litres of water.
- 1 tonne of steel requires 8,000-61,000 litres of water.
- 1 tonne of paperboard requires 62,000-376,000 litres of water.

The increasing demand and decreasing supply of water provides a particular challenge for industry. If it does not ensure adequate purification of its wastewater, then treatment and supply costs will rise, thus affecting the competitiveness of industry.

Water in Cumbria

As we turn to aspects of water in our county we face the problem of quality as well as quantity. Our lakes have become reservoirs (e.g. Windermere, Thirlmere, Haweswater, Ullswater, Ennerdale, Wastwater) and are used to supply water to homes and industry within and beyond the county. The problems are those of supply and quality. As we have seen in the press, there is a great deal that the water supply companies can do to reduce losses due to leakages in the supply system, but this is only part of the problem when demand exceeds supply. In times of shortage there is severe drawdown of the reservoirs which, ultimately, leads to a need to draw water from some of the natural lakes e.g. Windermere. This is a last resort, as it is costly to pump the water and it requires more extensive treatment than the water from the more pristine reservoirs. The heavy use of water from Haweswater has resulted in pressure on one of our rare fish, the Schelly, which lays its eggs in the shallow water. Over the past decade the drawdown has been such that the population has been adversely affected and eggs have had to be moved to undisturbed lakes in an attempt to stimulate the population.

The activities of water companies are not the only factors affecting rare species and, thus, threatening freshwater biodiversity. Pike fishermen have used live bait and discarded the live unused fish (notably Ruffe and Roach) into Bassenthwaite Lake and Derwentwater. This has had a direct impact on another rare species, the Vendace. The Ruffe eats the Vendace eggs and the Roach competes with the adult for food. Thankfully, some angling organisations have banned live baiting, but this ban has yet to be applied to Derwentwater.

The most important impact of the human population on Cumbrian lakes is, however, the discharge of sewage to our freshwater systems. Unlike intensive agricultural areas, the major input of phosphorus to our lakes comes from human sewage, particularly during periods of high demand e.g. Bank Holidays. Phosphorus, as any gardener will know, is one of the elements that we add as fertiliser to our gardens and fields. But our lakes are limited in their phosphorus supply and any addition to the water results in the development of algal "blooms", most notably, those of "blue-green algae" or, more correctly, cyanobacteria. These organisms cause unsightly scums and can be toxic. Grasmere is affected by phosphates used in the hotels and homes. Grasmere as a 'Sustainable Community' is promoting the use of phosphate free detergents to reduce the growth of blue/green algae in the lake.

A detailed study of Windermere showed that the bulk of phosphorus entering the lake came from human sewage. After a report was submitted, North West Water installed, at considerable expense, new treatment plants; the South basin of the lake is now recovering. This is not to say that sewage is always the major source of phosphorus; recent studies in Northern Ireland have shown that the agricultural soil has now become saturated with phosphorus fertilisers and this is being transferred, through rainfall, to the lakes and rivers. In 2006 the temperature of Windermere was the highest on record, affecting the plants and fauna of the lake.

Water in Britain

The distribution of rainfall in the UK is certainly not even and this places particular pressure on the south and the east of the country. Water levels in rivers and streams have become so low that they run dry; groundwater is becoming increasingly scarce and contaminated. The two major contributors to groundwater pollution are agriculture and industry. The major problem associated with agriculture is the leaching of nitrate-based fertilisers into the ground water. As a result, "Nitrate-Sensitive Areas" have been established to control the application of fertilizers where leaching through the soil by rainfall, depending on the different soils, might result in unacceptably high levels of nitrate in drinking water. The concern with regard to nitrate intake centres on the "blue baby syndrome" where infants consume, through bottle milk, too much nitrate, resulting in a blood disorder which may prove fatal. Against this we should bear in mind that parts of Europe use well water which contains levels of nitrate that are significantly higher than the WHO recommended limit, but exhibit no adverse effects in the infant population.

However, it is correct that the "precautionary principle" should prevail and that there should be a constant monitoring of potential pollution sources. These include leachates from landfill sites, industrial complexes and various smaller sources such as petrol filling stations (unleaded fuel contains an additive that can permeate ground water very rapidly with resulting contamination). Our water supplies are assailed by a range of "micro-pollutants" and the health risks are small but for some individuals could be significant.

Surface water, like ground water, suffers problems of excessive abstraction and pollution. A significant number of our rivers and streams now run dry in summer with adverse effects on the plants and animals that dwell in them. These problems are compounded by the discharge of sewage and industrial waste (particularly during low flow). Most recently, the Consumers' Association is warning of a possible deterioration in drinking water quality under a government scheme to introduce more competition into the privatised water industry. This could increase costs to customers in rural areas and those on low incomes. The Environment Agency reports a slow general improvement in standards but there is considerable scope for accelerating this. Reports of prosecutions for pollution show that some of Britain's major industries are the worst polluters.

Water - a global perspective

Climate Change will affect the situation with floods and droughts.

At the global level, there is increasing concern that human population growth above 6 billion (or even 3 billion) will place intolerable strains on water resources, particularly where they must be shared by several nations for diverse purposes, such as waterways, hydropower, irrigation, drinking water, industry, power plants and wastewater discharge. In groupings of countries, where environmental standards are permitted, international agreements on environmental protection only come about when collapse is imminent. By then it is usually too late: fish populations cannot recover, soils have eroded, salinisation of soils occur, and aquifers are exhausted or polluted, if on the coast, by sea water. However, not all "groupings of countries" exert a negative effect. The European Union has passed legislation which has forced member states to improve standards. In spite of this, according to a recent report by the World Wide Fund for Nature, more than half of Europe's freshwater habitats have been destroyed in the past 50 years with more than 85% of UK lowland rivers and streams no longer in their natural state. There is a great deal of fresh water on the planet, but it is in 'inconvenient places' such as Siberia, Canada, the Andes, the Amazon and Congo.

An even blacker picture is painted by de Villiers when, after reviewing the important role water has played in steering human history and recognising that most major rivers are trans-border, he concludes that wars over water are more and more likely than oil. We already see disagreements between European states with regard to responsibility for pollution; this in a region that is relatively well endowed with water. The problems for the arid zones, particularly of the less developed countries, are significantly worse.

- A recent report by the Met Office (2006) suggests that if the global temperature increase exceeds 2^0C severe droughts can be predicted all over the planet. There will be a global 'drying trend' which will affect irrigation and the supply of fresh water. In some places such as SE Australia, this is already occurring.
- Human water use will increase by 40% over the next two decades and 17% will be used for agriculture. It takes 1000-3000 litres of water to grow a litre of grain and the same for cotton. Genetically modified crops use more water.
- More than a billion people have no access to water supply and 3 billion lack adequate sanitation. 100 million Chinese and 200 million Indians rely on groundwater sources that are over-used or not being replenished.
- Much irrigation, perhaps as much as 30-50%, uses geologic supplies, including the USA grain lands with the vast Ogallala aquifer.
- In Bangladesh tubes wells have been drilled into aquifers laced with natural arsenic that will slowly poison the tens of millions of people living in 68,000 villages who are forced to use it. UNICEF sank the first of 900,000 wells expecting pure water.
- As rivers fail 30-50% of the world's agriculture depends on groundwater, mostly geologic. These water tables are falling by as much as a metre a year through overuse.
- Water diversions and dams for irrigation are having a devastating effect (the Yellow River did not run into the sea for 220 days in 1997, the Colorado no longer reaches the sea and the Nile is a shadow of its former flow). Even the Amazon has fallen, but this may be due to increased CO_2 limiting the natural respiration in the trees that sources this river as well as retreating glaciers. Damned lakes, such as the Aswan Lake on the Nile, evaporate and lose 25% of their water.
- Deforestation, land degradation, salinisation and contamination are all serious contributors to the loss of usable water. Add to this climate change.
- Trees, through expiration, are often sources of fresh water: Madeira, Yemen and the Amazon. A rise in CO_2 reduces this as the trees reduce their evaporation.

It is essential that the steps taken are appropriate in scale and methodology to each region that is affected by problems of water supply and quality. Building large dams, which will always cause silt problems and increased water loss through evaporation, may not be the best solution and may even exacerbate problems, including those of cross-border tensions. The giant Ilisu Dam project in Turkey, being built by UK engineers and financed by the World Bank, poses a threat to the fragile cease-fire in the region. Such involvement does not include public consultation, is a major source of Third World Debt and is often linked to arms sales in areas of arable land. Most dams are expected to silt up within fifty years. The massive Three Gorges Dam in China, one of 22,000 dams either built or under construction in China, will forcibly displace 2 million people, inundating vast areas, for both irrigation and energy. The Aswan Dam reduced the flushing action of the Nile, leading to a build up of salt in the soils. Mountain glaciers in the Himalayas which regulate the sources of many major rivers are declining due to global warming. Damming major rivers allows nations to regulate the water supply. At the same time it provides hydro-electricity. But in the long term there are serious problems.

Glaciers

Most of the great Eastern rivers are sourced through the vast glaciers of the Himalayas. These are now retreating due to global warming by as much as 25%. The result is either huge floods or droughts (made worse by de-forestation) as the melting glaciers no longer regulate water flowing down these great rivers. The engineering solution is to build dams, but these often cause more problems than they solve as the surface of artificial lakes lose 25% of their water from evaporation. Similar problems are found in the Andes in S America, Kilimanjaro in Africa, and in Europe.

Virtual water

This is the water that was used to irrigate the crops that feed and clothe us. The ordinary westerner drinks about a thousand litres or 1 tonne per annum. However to clothe and feed each person takes an extra 1500-2000 tonnes per annum. This is the virtual water needed to grow food and produce the

goods which are imported and exported such as the clothes we wear. When we buy cheap goods from severely water stressed countries or crops that rely on aquifers we are adding to the water crisis of the planet. 1000 litres of water is needed to grow 1 litre of grain, more if the crops grown are the 'green revolution' hybrids. It takes 2000 litres to grow the equivalent 2000 litres of cotton, yet hemp, which is just as useful, uses much less water and will grow in colder climates. Meat using grain for feed needs the equivalent of 11,000 litres for a half pound hamburger; a kilo of cheese needs about 5,000 litres. In Kenya, growing flowers for the First World supermarkets uses 25% of all the water needed by 100,000 people from Mount Kenya. Flowers, which use about 1 litre per bloom, are 90% water and Kenya is one of the driest countries in the world. Flowers and profit are competing with small farmers to their disadvantage and to the shortage of food in N. Kenya. The River Ngiro, Kenya's largest river, is a trickle of its former flow; one of the lakes in the flower growing (polytunnel region) is both polluted and being drained. A Jumbo Jet leaves Northern Kenya daily packed with flowers for the European market, adding carbon to climate change … but debts need to be repaid?

De-salinisation

Over 97% of the planet's water is sea water which cannot be used for irrigation or drinking. Some countries (e.g. Canary Islands) use desalination plants. These can be either evaporation or a membrane. Both need energy to make the fresh water. Current fossil energy costs are $100M for 100M cubic metres. De-salinisation of water is expensive. There is a scheme to raise water from the Arabian Gulf and canal it through Jordan to the Dead Sea and use the hydropower to desalinate the water. Such ingenious solutions to water stressed areas may be possible. Nuclear and other power stations are already used for desalinisation. This should be extended.

World Issues

The world's wet places are being emptied, even in the United Kingdom, though some coastal wetlands are being restored, and glacier sources threatened. It is likely that fresh water shortages will be more severe than oil shortages threatening the world's poorest peoples. There is rapid aquifer depletion in many countries. These are often geologic sources which cannot be replenished. Much of this water is used for irrigation of crops so food productivity is threatened as the water levels fall. Eventually in many valleys, if not washed out (as used to happen annually in the Nile valley before the dams were built), the irrigated land will suffer from salinisation and so become sterile. Dammed lakes lose about 25% of their water through surface evaporation.

- **Mexico**: A third of the water comes from underground supplies which are falling.
- **USA**: The vast Ogallala aquifer, a geologic aquifer, has shrunk by 24% and has been over pumped by 36 cubic kilometers annually. This irrigates the prairie grain lands which produce in a good year three quarters of the wheat traded on the world market. In the 1930's there were 600 wells into this aquifer, by the 1970's there were 200,000+. A quarter of this aquifer has now gone and it is estimated that it will last 20 years.
- **Saudi Arabia** relies on an aquifer to grow its grain. In 1980 this was 4.1 million tons. As the water tables fall this has dropped to 1.6 million and will eventually cease.
- **Iran**: Over-pumping is reducing essential water tables.
- **Yemen**: Water tables dropping at 2 metres per annum.
- **Israel**: Water tables falling, with the River Jordan more like a ditch than a river.
- **Gaza**, one of the driest places. Water tables dropping and being polluted by sewage and sea water.
- **India**: Thousands of irrigation wells run dry every year due to falling water tables. This is resulting in smaller grain crops.
- **China**: Water tables falling, rivers running dry. Irrigation failing. From 2002-2004 China went from being self sufficient in grain to being the world's largest importer. China is building or has built over 200,000 dams.
- **UK**: Severe water shortages in the South East as aquifers not replenished due to changing, drier conditions (wetter winters and drier summers).
- **Lake Chad** in Africa is drying up due to irrigation and damming of source rivers.

Rivers running dry

- **Amu Darya** originates in Afghanistan and feeds the Aral Sea which has shrunk by more than half due to cotton irrigation.
- **Colorado**, USA. Now rarely makes it to the Gulf of Mexico.
- **Fen**, China. Now disappeared. One of the major Yellow River sources.
- **Ganges**, India and Bangladesh. Barely reaches the sea.
- **Indus**, Pakistan. Now barely reaches the sea due to dams and irrigation, which is leading to salinisation of the soils; losing 1/10 of the land.
- **Nile**, Ethiopia, Sudan and Egypt. Now only a trickle when it reaches the Mediterranean.
- **Yellow**: Major river in China. Frequently runs dry.
- **Mekong**: One of the most prolific rivers, and a major source of food in the region, has reduced flow due to dams on its sources.
- **Murray River**, Australia is now run dry to the sea due to irrigation, which is also drawing salt from evaporation and killing the crops through salinisation of the soils; largely growing cotton.
- **Amazon**: Depends on two sources: the Andes and the rainforest. The rainforest maintains its own high moisture levels though tree expiration. With higher levels of CO_2 the trees are not breathing as long and so are not expiring as much moisture. This is affecting the rainfall, river flow and the fertility of the soils as well as the jungle itself.

There are also competing demands between agriculture and irrigation and people living in cities, who tend to waste water and tend to take priority over growing food.

Small Solutions or Micro-Conservation.

- **Pepsees:** A coil of black perforated plastic tubing which drip feeds water to crops without wasteful evaporation. This is called drip irrigation. Large farms in Israel, India, California, Tunisia and Jordan raise water productivity 35 fold. Small farmers find it expensive and so do not use it. This simple technology could save many potential and current water shortage areas. (Pearce pp 339-44)

- **Dew Ponds:** For centuries dew ponds have been a source of fresh water. They are man made, straw and clay lined ponds on top of local hills. The moist night air condenses into the ponds and sustains a supply of clean fresh water. Hill top location is crucial for the pond to generate its own water from the air.

- **Rainwater harvesting:** In many places rainwater from roofs and elsewhere is run off into tanks, often underneath the buildings. This prevents evaporation as well as conserving water and cooling the houses. Common in many countries before tourism and industrialisation.

- **Composting toilets.** A great deal of water is wasted in toilet flushes. Composting toilets are less wasteful and are sweet to use. The sewage is no longer wasted. It is a valuable natural fertilizer.

Conclusion.

Water is our most precious resource and terrestrial life cannot live without it. Approximately a third to half our food is grown using aquifers which are not being replenished and in many ways we waste water. In the future all water, even in water rich areas like Cumbria, must be conserved and treated like the vital life giving resource it is. The technology and the science of this are well understood. This is a fundamental problem for the poor of the Third World who tend to be those who suffer from thirst and pollution. Climate change will severely affect the supply of water we need and the food we grow. Thirst and starvation could become even more common unless we can reduce our carbon emissions by 60% as a global average by 2030 or 90% in the rich First World. Wars could easily be fought over catchments that cross national borders. A statistician called Igor Shiklomanov has studied water trends

over many years and his conclusions suggest that 'there is a steadily narrowing gap between clean water supply and water demand, water for drinking and water for food, water for sanitation and water for industry'. Drought is likely to increase considerably with climate change and global warming, by as much as 30%.

'Water wars might be caused by human folly, but they might also be prevented by human ingenuity' (de Villiers p 365)

Further Reading/Sources

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