Cows, Groundwater and Concerns

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Water is very important! We need to understand it, but at present many of the facts needed are not available. We have all seen much surface water, but how few realize that in a world view less than 10% of the liquid freshwater on earth is visible from space!

Here in Canterbury, the plains were made by the action of ice, gravity, and water. When in the ice ages, sediments from the mountains were moved to form the Plains much fine sediment was lost far out to sea. This has often left us with soils that are often open, and very free draining. The spaces between the gravels and finer sediments accommodate much groundwater.

The greywacke rock from which Canterbury is mostly made, has a long history of being ground down, washed out to sea, hardened, and then uplifted above the oceans, and the whole process repeated again. We do not really know how many of these cycles there have been, but the process has ensured that virtually all of the soluble materials in the rocks have been removed. For this reason the water that flows from the mountains, across the plains and out to sea again is very pure. There is nothing much left to dissolve. This explains the lack of plant nutrients in our soils, and the need for fertilizers.

The sizes and shapes of the spaces in the soil vary markedly, but as long as these spaces are interconnected, the water they contain moves down hill. Some water returns to the surface as springs and rivulets, contributing to streams and rivers, but the rest remains buried as groundwater, and moves inexorably towards the sea, but often very, very slowly so that the journey to the sea may take a century or more.

As sediment-movers, rivers often tend to build up their courses above the surrounding land. Then some water leaks from the river and into the land, and groundwater. In other places streams scour incised channels and much water remains more or less "in place" till it reaches the sea.

In the trip from the alps to the sea the groundwater part is the least familiar bit. Groundwater exists at a variety of depths, and because the water moves through different sized voids, and under very variable pressures, it moves at variable speeds. The underground channels have existed for variable times, and have different histories. Surprisingly to some, these water-filled spaces are the living spaces or habitats of a great mixture of mostly minute, invertebrate (backbone-less) animals. These animals were first discovered in Canterbury, about 1880 by Professor Charles Chilton in well water at his farm in Eyreton. Chilton tried to alert the scientific world to the presence of these variably buried animals of darkness - now known as the stygofauna, but his work was generally ignored for the next century.

The crustaceans he named were the largest of these animals; similar to, and about the same size as the distantly related sand hoppers of the sandy shore. In the last 50 or so years, many more stygofaunal animals have been found, and just over a hundred groundwater animals have names. The National Institute of Atmospheric and Aquatic Research (NIWA) estimates that there are at least 500 hundred different kinds of animals in our groundwaters. There are a number of shrimp-like forms, some insects, some tiny snails, a variety of mites, and many "wormy" animals and others. They live by eating the residues of living things that have found their way down from the surface, many microbes, and each other. Underground there is no light, and plants cannot grow, so nourishment (carbohydrates and proteins) is not produced. Food material is either washed or carried into the soil. Nowadays the burrows of the abundant introduced earthworms provide convenient access routes for food and water.

It is hard to sample these animals to discover their kinds and numbers. Most are tiny, but the 1 millimetre holes in the walls of well pipes that let us take water, are too small to let the larger animals like Chilton 20 millimetre shrimps get through into the pipes. The 1mm. holes may get even smaller if they become fouled up. However, the fauna also "processes" the sediment in the interstices of the waterways in the ground, and so facilitates the movement of groundwater. Dr Graham Fenwick of NIWA has found that at Templeton a stygofaunal crustacean *Phreatoicus typicus,* can ingest, and digest, living bacteria gathered from the clay-sized particles lining the water channels. From his experiments he found that this animal can process 7-28 tonnes of sediment per hectare per annum, and from that they can assimilate 120-650 g of organic carbon. We know that the guts of these creatures are commonly packed with bacteria and other micro-organisms that they are digesting. It is generally agreed that in the past these little creatures have done a good job of filtering the groundwater and removing a great many of the potentially disease causing "bugs". Because the water is slow moving, and is often underground for many decades, they formerly had plenty of time for their work. They kept the water clean, and pure enough for us who drank it, to remain healthy, and free from water-borne diseases.

But things have been changing. Before the Maoris came the plains were covered in trees and scrub, and the soil was probably covered with forest litter, and the rain percolated through that organic matter. Maori hunters removed much of the forest, and the European settlers burnt off the rest. Introduced grasses and earthworms colonised the plains, and native insects that formerly lived at the river margins, and on the edge of the forest, like grass grubs, porinas and army worms found a new heaven in the new grasslands. They coexisted fairly well with the newly introduced sheep.

Sheep are careful about water. They try to keep out of it, and seem to treasure it. Their faeces are dryish, small pellets, that quickly lose more water and trap most of the micro-organisms and parasite disseminules inside. The European cow is very different! Cows love water. They move into it. They feed on lush marginal vegetation, and when their ankles are wet their bowels and bladders open, and the stream waters receive masses of fine semi-digested plant remains, parasites propagules, and other micro-organisms, as well as much nitrogenous waste. As wild animals the European cattle inhabited grasslands at the margins of forests, and often apparently moist land near stream margins. Today cows still love to hide their newborn scentless calves in scrubby thickets. Their hooves spread readily and help prevent bogging in wet pasture.

Modern farmers dose their animals with drenches and "pour-ons" of new formulations. These chemicals work by preventing transmission of nerve impulses in invertebrate animals. This prevents the proper coordination of parasite behaviour in the dosed animals. The parasites on the outside, like fleas and ticks can no longer hang onto hair or hide, and internally the tapeworm crown of thorns and suckers no longer grasp the gut wall, the flukes suckers do not work either, and the round worms cannot wriggle and remain securely in place.. When urine passes out into water these materials also affect the streams inhabitants, and they lose their grip, and the fish’s food supply goes down stream! Such drenches are effective at very low concentrations. Some drenches remain active inside the cow longer than others do.

Canterbury was not designed for cattle, and they do not naturally occur here. For too much of the year the climate in some parts is too dry. Irrigation is a short term remedy for this. In the really long term we do not know what increased wetness will do to soils.

Irrigation involves capturing water in one place and releasing it in another. Up to the present there has been no attempt to relate irrigation from surface waters and underground waters. The different sources of water have been managed as if they are separate and unrelated. Often when streams are low, the groundwater is heavily used. We do not know what effect lowering the aquifers to variable extents for variable periods has. Some aquifers take a long time - more than a year, to recover from periods of heavy use.

When the groundwater is lowered by a few metres or more what happens to the stygofauna? Have we reduced, or eliminated the stygofauna’s ability to remove the pathogens that irrigation is introducing into groundwater? What happens to these animals when we take away the water? Do they die? Why not? How long does it take for them to be reinstated, if indeed they are replaced? Who knows? Is there a limited period or extent of water lowering from which the resources can recover? Is there a period where the pathogens survive?

Sadly, we do not know the answers to any of these questions. Maybe some animals can tolerate having the water taken away for a spell. Some of the tiny animals that live in soil, like some nematodes (round worms), tardigrades (water bears), and rotifers (wheel animalcules) can tolerate being dried up for considerable periods (decades in some cases), and on re-wetting can resume life as if nothing had happened. Some of these animals have adhesive glands, and can glue themselves to the substratum, and thus avoid removal by pumping. In fact we do not know what the effects of removing the water can be on the animals that live there. What happens to us if the animals that protected us are killed off?

So the big problem in managing our water resource is that we cannot predict the effects of many actions. In the past the amount of water taken was usually very small in relation to the size of the resource, and in surface water takes we could look, and see how much was left, and the effects our takes were having. Now we want to take large volumes from the groundwater, but we have little idea what effects we are having, and what the result will be.

We believe that the stygofauna is slow at reproduction. Their habitat is not rich in nourishment, but in the past the habitat was very stable. There was no value, only disadvantage, for those animals to build up numbers rapidly. Now when we have a drought and surface water does not meet our needs we are happy to take vast quantities from the ground where in the past, stability ruled. How long will it take to return to "normal"? Will it take months or decades, or perhaps never? What will happen to us while we await a return to the old state?

In the past most groundwater was constantly of high quality. Recently we have seen signs of polluted groundwater. Will this be temporary, or a preliminary warning? If we continue to pour vast quantities of dung and urine onto our soil, and then try to "water it in" what will that do to us? Will we so load the water under porous soils with organic matter that its decomposition will use up the oxygen, and asphyxiate the stygofauna. If we take too much groundwater will the stygofauna die? Will water borne diseases cause grievous sickness in us and our animals? Will the resource ever recover?

We need to be aware that there are a good number of kinds of micro- organisms in the groundwater. Some bacteria like *Campylobacter* are not fussy about their host animals, and live in many kinds of mammals and birds. Protozoans like *Cryptosporidium* can flourish in us, and produce severe diarrhoea. It flourishes for a time in calves, but these usually become immune after a few months. The cyst walls are thick and protect the contents from drying, and from chlorination, and there is no drug available to treat such infections. In Spain, and the Chesapeake Bay in the U.S. it is a serious pest in the tissues of farmed mussels and oysters. Itis not fairly readily removed as are the bacterial contaminants. Is this pest to become a new headache for the proposed marine farms in Pegasus Bay? The sewage outfalls may be a handy source of infection. At present I know of no interest in regulating the disposal of wastes from calf rearing facilities. *Cryptosporidium* is thus free go wherever wind, water or flies take it. Because the cysts multiply rapidly once inside a new host, the minimum effective infective dose is a single cyst. I have not found any study of the incidence of the parasite in New Zealand, but it is widespread. In Canterbury human cryptosporidiosis outbreaks regularly follow calving in spring and autumn.

There are no grounds for being reassured about the human health consequences of our huge expansion of dairying. In Canterbury we now have about 700,000 milking cows plus their calves which bring on milk production, and become the replacement heifers are needed to replace ageing cows, and to create new herds. If to avoid being alarmist, we ignore the calves and heifers, and all the beef animals, and the males, it is a simple matter to multiply the 700,000 cows by 25 kg to get the amount of dung produced per day, and divide that by 1000 to find how many tonnes that is. Then we can multiply by 365 (days in the year) to get the annual dung production. That gives a very conservative estimate of 6,387,500 tonnes of cow dung per annum as a modest estimate. Could we now be facing pollution and health problems?

So many animals eat a lot of herbage. To produce that food much fertiliser is used. Clovers seem to have lost favour in some quarters. The use of nitrogenous fertiliser has increased several fold in recent years, and much ends up in our water. Many sites in Canterbury now have domestic water supplies with more nitrate in them than is allowed by the New Zealand Drinking Water Standards. Nitrate in such quantities is not good for bottle-fed babies, or for our farm animals, and agricultural research workers are trying find ways around this problem. Excessive fertiliser use needlessly increases production costs.

Sue Macky an experienced veterinarian, wrote articles in the February and March issues of the journal *Vet Script* that drew attention to the poor quality of animal husbandry seen on some dairy farms. She noted that many traditional ideas about animal care have been carried forward from the past, but without appropriate adjustment for recent changes in the industry. For example, management is often based on "so much per animal" but forgetting that the rules evolved when most dairy cows were Jerseys, not Holsteins that weigh about twice as much. A consequence of this is that in many herds, heifers often in poor condition, produce their first calves, and remain in poor condition for that and subsequent lactations. The idea was advanced that production could be increased at no extra cost, if fewer, but better fed cows were carried. When experienced professionals write such things, we should listen, and be prepared for some soul searching. Of course many herds are very well managed, and such observations do not apply to them, but husbandry on many corporate, and some private herds could be reappraised with profit.

How thoroughly consent authorities monitor water for the presence of pathogens is unclear. Many, like Ecan, only look for *Escherichia coli,* so we know little of the occurrence of other pathogens. This is not just an academic exercise. There are potentially grave problems for the future. If polluted groundwater becomes common, as appears to be happening, who pays? Why should the water drinker, or tooth cleaner pay to remedy the evil visited upon him by irrigators actions? I doubt if it will be possible to identify the irrigator responsible for the pollution, or the death of the stygofauna, so who should pay? If local authorities must spend large sums on installing, operating and maintaining water treatment facilities who should pay?` There are thousands of wells in Canterbury. If treatment facilities have to be installed who should meet the costs? Why? It was unfair when some Regional Councillors voted to make everyone pay abstractors costs. What do you want for the future? I fear we cannot depend on the new Commissioners to do it for us. Much thinking is need about water. We should do it, and call a halt to the degradation of our water resources.

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