Groundwater irrigation in England

Globally, groundwater irrigation has grown rapidly over the past 50 years. It supplies over one-third of the world's irrigated area and has emerged as a strategic resource in both arid and humid climates because of its capacity to support intensive land use, and high-value agriculture. Here is the UK it accounts for less than 10% of water abstraction for irrigation.

Groundwater abstraction for spray irrigation in England was between 1.2% and 2.6% of total licensed groundwater abstraction between 2000 and 2016. The highest use area is East Anglia where groundwater abstraction for spray irrigation reached 8.9% of total groundwater abstraction in the region in 2011. The use of groundwater for irrigation in England reflects the location of high yielding aquifers such as the Chalk and Sherwood Sandstone, and the intensive growing areas in East Anglia and the Midlands.

The primary advantage of groundwater over surface water is consistency in yield and quality. Flow in streams and rivers varies from very low or possibly nothing, to very high; and generally, flows are low when irrigators need water. Also water can be available locally, close to where it is used to irrigate the crops.

The quantity and quality of the water in a river varies quickly and dramatically depending on the flow and upstream activities. In contrast, groundwater quantity and quality are more consistent. The amount of water available is constrained by the design of the borehole and the hydrogeology of the rocks which make up the aquifer. Water quality is of course subject to abuse in terms of over-abstraction and pollution.

In terms of yield, "The ground will give you what the ground will give you". This means that drilling a bigger, deeper borehole will not necessarily give you greater yield. Drilling more boreholes may allow you to get a greater total volume of water, but each borehole will more or less have a similar yield. The yield of a well-designed borehole is controlled primarily by the permeability of aquifer material. A borehole drilled in clay will yield very little, whereas one drilled into sand may yield a great deal.

Because boreholes may not yield what you need, this leads to a supply/demand imbalance. If pumped over a period, the borehole may provide enough volume. But to bridge the gap a reservoir is needed to build up the volume and to deliver higher discharges. Borehole/reservoir combinations are a useful way of managing sustainable abstraction.

Sustainable abstraction

Sustainable abstraction, where impact is minimised, is entirely possible. It is controlled by the amount of water in the groundwater system; the rate of replenishment from rainfall; the rate of abstraction, and the quantity abstracted. If more water is abstracted than is recharged, groundwater levels will fall regionally and not just locally around the well or borehole. However, because recharge varies over a wide range of timescales from weekly to decadal, getting the balance right is difficult. Making the balance over too short a timeframe can greatly restrict abstraction; making the timescale too long can result in unacceptable effects and impacts.

However, continuous pumping of groundwater, in excess of recharge will lead to serious impacts ranging from saline intrusion, aquifer dewatering, land subsidence, sink hole development and environmental degradation.

Abstraction from a borehole causes the groundwater level (water table) to fall or depress locally. The shape of this depression is approximately circular and is cone-shaped in 3D. The abstraction intercepts water in the natural water system and essentially moves it from where it was going to somewhere new. The abstracted flow is no longer available to support rivers and wetlands and herein lies the potential for conflict with other water users.

Intercepting the flow and fall in the water table can lead to effects that impact on other abstractors and the environment. The extent of the impacts depends on the geological setting, the distance between abstraction and receptor, and the system hydrogeology. The uncertainty this creates is one of the reasons why the Environment Agency may restrict groundwater abstraction where it is deemed to be reducing rivers flows that are fed from groundwater and where the river is not meeting the requirements of the Water Framework Directive (WFD). This is a not an easy assessment to make because of the complex interactions along the pathway from intermittent groundwater abstractions for irrigation, to impact on river flows, and hence on river ecology.

A major advantage of appropriate seasonal abstraction for agriculture are the periods of no abstraction between growing cycles. In temperate climates, this usually coincides with cold wet periods when groundwater recharge is occurring.

Licensing

Abstraction of groundwater will impact the rest of the water cycle. To maintain sustainable abstraction the water cycle must be kept in balance. Abstraction in the UK, as well as many other countries, is controlled by a licencing system designed to balance the needs of abstractors with those of the environment and the amenity value of the water in lakes, wetlands and rivers.

Making licensing decisions to maintain the balance is difficult, and in complex systems are often based on expert opinion rather than scientific evidence, which is difficult and expensive to collect. Scientific debate on impacts can lead to inappropriate use of the 'precautionary principle' – if in doubt err on the on the side of caution, thereby curtailing abstraction unnecessarily.

While it is essential that the balance is found, the decision-making process forced by the WFD can impact on sustainable growth, with little measurable improvement on the environment, an approach which has resulted in irrigators having their licenced abstraction reduced during licence reviews.

The balancing act is not easy in a system that is primarily driven by the weather and its variability over different timescales from days, through seasons, years and in the case of groundwater potentially millennia. Despite this, having a management and licensing system is far better for everyone than having no system at all. You just mustn't believe that every answer that the system gives is correct!

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