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Causes and effects of fluctuating groundwater levels

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Groundwater use began in the Lockyer in 1942 and from then until about 1967, there was very little fluctuation in the level of the water table in the Lockyer alluvium. If the water table was falling, it was not brought to the notice authorities.

Water levels began to fall in about 1970 when Haigh (1970) wrote: 'With the large volume of underground water available, water levels must be drawn down during periods of low replenishment to make use of this available storage'. By so doing, he would have been creating a 'dam' which would be filled by the next large runoff event.

In making this statement, Haigh misunderstood the purpose and functions of the initial store of water found in the alluvium and thought it was just part of 'the water supply for irrigation'. In 1949, the Bureau of Investigation had correctly stated that 'the supply available annually will be roughly the annual replenishment, periods of low replenishment being met from underground storage'. This was a quite reasonable statement provided it was understood that the period of low replenishment was confined to the current irrigation season and did not continue for two or more years thereafter. This was because the supply available annually was relatively constant from year to year and did not fluctuate wildly like surface runoff which fills dams, usually during *la nina* phases of the SOI cycle. But this was not known in 1970.

The approximate average annual recharge had not been determined by 1949 (Bureau of Investigation 1949). The Bureau saw the initial supply as the reserve supply which could be used during the dry season of the year but only to the limited extent that could be made up following subsequent (summer) rains. This could not be known exactly in advance in any given year because the shortfall incurred during the dry season (which coincided with the irrigation season – April to October) or the subsequent summer rains (in November to March) cannot be known in advance.

In 1949, the Bureau was not aware of the existence of basalt aquifers on the Main Range or of the springflow it delivered at a relatively constant rate provided the basalt aquifers were regularly replenished.

However, it did not explain why alluvial aquifers should not be drawn down by more than the 'average annual replenishment'. The reason is that, if groundwater levels are allowed to fall, irrigation farmers in parts of the alluvium with shallow depths of groundwater would lose access to their water supply, thereby depriving them of their livelihood. Evidently, this was of no concern to the civil engineers who managed the system but it is of vital concern to irrigation farmers and to agricultural extension officers who advise them. The community had been assured that the water supply was sufficient to supply 10 000 ha with approximately 3.3 ML/ha 'for the foreseeable future' and on that basis farmers invested in costly irrigation farming infrastructure which had to be paid off. To be suddenly deprived of their water supply, on purpose, 'to make use of this available storage', was completely unacceptable.

Rather than drawing down the water table, the correct management task would be to maintain the water table at as close as possible to its initial high level. If this was done, the area served by the groundwater would be at a maximum and the maximum area would be capable of being recharged. This would mean that only a modest amount of water would be available for each hectare on the alluvium and this would vary slightly from year to year, depending on the streamflow available for replenishment.

In the Lockyer, water levels have not fallen because of 'drought' as has been commonly believed. They have fallen, 'on purpose' because of the management system imposed. It was evidently believed that management of surface and groundwater schemes is similar, both being replenished at erratic intervals by overland flow. It was not appreciated that, unlike surface dams which are filled quickly by overland flows, alluvial groundwater is recharged slowly by long-duration springflow, because of the very slow rate of movement of groundwater in sand/gravel aquifers. The aquifers do not permit rapid intake of streamflow. The extent of drawdown during an irrigation season must not exceed the volume of water which can be supplied in the ensuing year.

But it may not have been realised that the water which replenishes the alluvial groundwater is itself groundwater which is itself discharged from springs served by free-draining basalt lava aquifers on the Main Range. The aquifers which supply the springs may have an area of some 65 400 ha, almost twice the area of the alluvium. These aquifers are recharged in a few days by heavy rainfall but then release the water slowly because of the small cross-section area of springs. The stored water is discharged over months or years, providing the low, long-duration flow which is most effective in replenishing alluvial groundwater. Because it is underground, it is free from evaporation loss as happens with surface water storages.

The Law of Diminishing Returns applies to irrigation water, just as it applies to all other inputs into agriculture. The highest return per ML is given by the efficient application of 1 ML/ha to supplement the erratic rainfall to allow crops to be established at the correct time and to nurse them through the inevitable dry spells which occur so as to make maximum use of rainfall. Provided the water is distributed equitably, some farmers may choose to apply only 0.5 ML/ha to a larger area in years of high rainfall or 2 ML/ha to a smaller area in drier years. Some farmers have found that by carefully monitoring soil moisture and adjusting irrigation accordingly, as much as $13 000 per ML (gross) ca be earned; much more than can be earned by using less-efficient irrigation methods.

However, to apply this technique valley-wide, it is necessary to know the approximate volume (ML) of replenishment available and this can be done only by measuring all water use. Then, the area of good quality agricultural land suitable for irrigation needs to be determined, together with the area of such land on each commercial irrigation farm, so that each farmer can be allocated irrigation water as ML/ha of good quality irrigable land.

To ensure that this volume can be applied indefinitely, it is necessary to recognise that each groundwater basin has a maximum stable basin yield (MSBY) which must never be exceeded. It is determined by the volume of replenishment in every year. As this cannot be determined in advance, the community must decide on an optimum basin yield (OBY) which is slightly less than the MSBY, and which will be related to the volume of replenishment of basalt aquifers which is determined by the summer rainfall on the Main Range. An early start should be made in measuring rainfall on the Range and the volume of annual use to establish this relationship.

When this relationship has been established, it will be possible to regulate the total volume of water use in the valley so as to maintain a constant, high water table and equitable allocation of water to ensure the highest possible return from the limited volume of water available. Because it is allocated equally (as ML/ha) across the whole of the alluvium, this will lead to cooperation in water management to replace the current conflict caused by the current inequitable ('self-management') system which promotes unsustainable use and conflict.

The principles underlying this new system may be stated as follows:

"So to use your own as not to injure others": (Sic utere tuo et alienum no laedas) (Trelease 1974).

"Justice is a good so fundamental that it is part of the natural order of things". (Ancient Egyptian principle.)

"The mercenary sacrifice of the public good to a private interest is the eternal stamp of vice" (Emerson 1868).

The golden rule also applies.

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