Comments on the Draft South Coast Regional Water Strategy

Glossary

The Guide, page 40, defines “Stormwater” as “Flow generated from hard (impervious) surfaces.” This is different from a dictionary definition (e.g. Macquarie 6th Edition “a sudden excessive runoff of water following a storm”) and reflects a fundamental lack of current understanding of how catchments work.

In the 1920’s, Horton proposed that a typical hydrograph (a plot of flow versus time) could be described as baseflow, which is maintained by the slow percolation of water through soil towards the stream, and stormflow, which he said occurs when rainfall intensity exceeds the surface infiltration of the soil, causing rapid overland flow. (See review article by Bonnel,1993).

In the 1960’s, Hewlett and Hibbert (1967) closely observed runoff generation in temperate forests in North America. They found that rainfall intensity almost never exceeds the surface infiltration capacity of catchment soils. Rather, they observed that overland flow was generated from a “variable source area”, usually in the riparian zone. In this variable source area, exfiltration of water (derived from interflow of water through the soil profile higher up the catchment) through the soil surface, added to incident rainfall, produces overland flow. This is the “quickflow” runoff that can be counted as stormflow in a catchment hydrograph. .

Subsequently, Emmett O’Loughlin and colleges (O’Loughlin, Cheney and Burns, 1982) developed the “TOPOG” model which describes mathematically the variable source area concept of stormflow generation in temperate catchments.

In brief, TOPOG divides a catchment of a first order stream into pixels bounded by contours and lines at approximate right angles to the contour. The Richards equation is solved for each pixel. (The Richards equation quantifies the movement of water through soil.) TOPOG sums the water flow through adjacent pixels plus incident rainfall to generate a hydrograph for the catchment outlet.

So the definition of stormflow in the glossary is outdated and would now be described as “Hortonian overland flow”. It occurs in bare and compacted areas such as road surfaces and dairy laneways. For most of the South Coast catchments, stormflow is generated from a variable source area, the size of which is determined by antecedent wetness.

Stormflow runoff can also be generated by “subsurface stormflow”, sometimes referred to a “throughflow”. This is especially significant in geologies with fissures in the regolith and in logged forests, where decaying roots become, in effect, pipes.

A conceptual understanding of how catchments work is useful for understanding how historical changes in land management have affected the hydrological regime. A clear conceptual understanding of how catchments work can also inform strategies to restore catchment values such as persistent flow duration during dry periods.

Introduction.

Since European invasion and settlement, a number of changes have degraded catchment values. These include soil compaction by hard-hoofed animals, draining of wetlands, road construction and the associated altered and concentrated drainage patterns, gully erosion in intense rainfall events following land clearing, with the consequent accelerated drying out of riparian areas, and water extraction for irrigation and town water supplies. The only developments reversing these impacts on flow regimes are the construction of water storages and detention basins.

We do not have hydrographs from the pre-European settlement era but we can infer what they might have been using fluvial geomorphology and by studying the (very few) remaining intact catchments.

The Far South Coast Catchment Management Committee commissioned Professor Gary Brierley and his team from Macquarie University to study the fluvial geomorphology of the Bega catchments. . Fluvial geomorphology studies (e.g. Campbell Murn in the Cobargo (Narira) Catchment, Gary Brierley and Krystie Fryers in the Bega Catchment) have described how land clearing following European settlement lead to massive erosion of sedge and tea-tree swamps at the foot of the escarpment. (Brierley and Murn, 1997, Fryers and Brierley, 1998)

In brief, about 21.7 million cubic meters of “bedload sediment” has been eroded in major rain events following vegetation removal. About half of this forms the Bega Sands Aquifer, about 11% has gone out to sea (along with the fines and organic matter) and the rest is in transit. This has made the flow regime in all our streams much peakier, with worse flood damage and poor flow-duration into dry periods.

Coastal streams have changed from a “chain of ponds” form, where dense sedge vegetation filters flow between a series of pool habitats, to deeply incised gullies and sand-choked reaches with little or no surface flow between significant rainfall events.

The Healthy Rivers Commission report on the Bega Catchment emphasised the need to repair the riparian corridor as a priority (Crawford/HRC, 2000). In negotiations over the Bega Water Sharing Plan (as a representative of the Bega Environment Network) , I cited the relative paucity of native fish species in the Bega vs Brogo rivers and the poorer macroinvertebrate diversity in pool-edge habitats (Australian Water Technologies/Growns, 1998) as evidence that low flows in the Bega river required better protection from excessive extraction. The deal negotiated was for continued access to low flows by dairy farmers for dairy wash-down and some limited irrigation in return for a program to restore native vegetation along the river corridor.

Subsequent drought years meant there was little effective progress in native riparian vegetation restoration. Then the massive flood event of March 2011 smashed riparian fencing and plantings.

The commendable attempts by Local Land Services, the BVSC and the Bega River Anabranch Wetlands Landcare group to restore native vegetation at the Bega Riverside Park, Spenco lagoon and Bega/Brogo Anabranch have been repeatedly set back by massive flood events such as 2011, 2012 and 2016, with subsequent weed invasion.

Restoring the riverine corridor without first restoring the flow-regime is likely to be a frustrating, expensive and perhaps futile exercise. As stated earlier, European settlement has involved significant land clearing, especially of the vegetation on high fertility soils supporting sedge and tea-tree swamps. These have incised in significant rain events resulting in massive soil erosion and a change in the hydrological regime so that flood damage has increased and flow duration into dry periods had decreased.

Unless the hydrological regime can be repaired and restored, there will be more conflict over access to low flows and continued poor river health in aquatic and riparian environments.

Comments on the Long List of Options.

1. Brogo Dam to Bega Pipeline.

The Bega Sands Aquifer has been estimated at 30,000 ML, with about 6,000 ML accessible by the existing pumping infrastructure. The surface level adjacent to the bore-field is about 7 meters above sea level. Sea level rise is not expected to reach this extent unless the West Antarctic and Greenland ice sheets collapse, which could conceivably occur suddenly. Even if this were to be imminent, the construction of a barrage at Bottleneck Reach might be a more economic option.

Another more economic option might be a shorter pipeline from the Brogo River well downstream of the dam but safely above king tide levels.

6. Pipeline connection between Bega and Eurobodalla water supply networks.

The distances involved are considerable, e.g. 80km from Brogo Dam to the Tuross settlements.

From discussions at the SCTC meeting of 26/11/2020, I got the impression that the major impetus for the option was that there may federal funding available for an increase in the capacity of the Brogo Dam, since it is partly an irrigation storage. The fact that grant money might be available is not a sufficient reason to support any particular proposal. It should make sense on its own merits.

Following the "Millennium" drought, the BVSC constructed a pipeline from the Bega sands Aquifer to the Yellow Pinch Dam, in order to supplement dam filling from the Tantawangalo creek weir. It seemed this might be a "white elephant" during subsequent wet years but the recent severe drought culminating in the 2019/2020 bushfires proved its worth for the southern part of the BVSC. Water restrictions were averted and town water supplies were available to defend urban areas from the threat of wildfire.

The Bega sands to Yellow Pinch pipeline proved its worth but it is much shorter than the distance from the Brogo to the southern Eurobodalla network.

16. Increased on-farm water storage.

Restoring the hydrological regime in coastal streams can be, to some extent, achieved by increasing on-farm water storage throughout the catchments. The SMEC report (Bega River Catchment, Water Storage Project, November 2007) found that large on-stream storages would provide a poorer outcome in terms of meeting irrigation demand that smaller storages distributed throughout the catchment because the latter would provide benefits to many more farms.

Filling on-farm storages by extraction from streams has major disadvantages, namely the cost of pumping and the limited availability of water at low and medium flows. A better option would be to

- Locate storages as high as practicable in the landscape
- Fill such storages by the interception of stormflow runoff with feeder drains
- Manage the flow in feeder drains using "smart culverts" (These are culvert- wells placed at intervals along the feeder drains with a through-pipe leading along the feeder drain towards the storage and a pipe under the wall of the feeder drain , whose inlet is above that of the through-pipe. This limits the flow to the storage in intense rainfall events and therefore avoids significant erosion along the feeder drain and obviates the need for a concrete-armoured spillway on the dam.)
- Utilise the water stored, as soon as economically opportune, by gravity-fed irrigation.

The hydrological effect of capturing stormflow runoff high in the catchment and releasing it for irrigation in dryer times would be to maintain a proportion of the catchment soils in a wetter condition for longer overall. Baseflow in small tributary streams could be so some degree sustained and subsequent small rainfall events would be more likely to produce some additional streamflow.

The availability of surface fresh water throughout coastal catchments could make an important contribution to facilitating the response to bushfires. Having some of the pasture lands in a greener condition for longer into the summer drying period would also provide some bushfire protection.

The construction of many new on-farm dams throughout coastal catchments might potentially contravene existing provisions of water sharing plans, such as the "harvestable rights" limit and restrictions on dam construction on higher order streams. The latter should not be a problem if dams are sited high enough in catchments and filled by feeder drains.

Harvestable rights are set at 10% of average runoff, which may be a negligible proportion of runoff in wet years and a highly significant proportion in drought years. It would be better to focus on the proportion of stormflow runoff captured and stored and subsequently used for irrigation to wet catchment soils in dry times. The SMEC report shows how little of the total available (modelled) streamflow is licensed for use (SMEC 2007 page 48, figure 28). Note that median flows are considerably lower than average flows because infrequent but very large flood flows skew the distribution.

In order to encourage a reduction in the extraction of low flows, the Bega Water Sharing Plan offers increased access to water from higher flow classes as a trade-off for the surrender of "A class" water access. This has not been taken up due mainly to the high cost of double-pumping from stream to off-stream storage then from off-stream storage to the irrigation system.

Some pilot projects whereby stormflow runoff is captured by feeder drains and stored in dams high in the landscape might be offered a subsidy for dam and feeder drain construction in return for access to data collection to assess performance.

Feeder drains intercept a proportion of interflow (the lateral movement of water through the soil profile towards drainage lines) and any incident rainfall on their compacted surfaces. As such, they impact baseflow, through-flow and stormflow generation. However, the preponderance of total annual runoff in coastal streams is in very large flow events. Analysis of the area under hydrographs or flow-duration curves suggests that around 70% of the total annual volume of flows might be out-to- sea within a week of the rainfall event. Some of this flow in “freshes” is useful to aquatic biota but most of it is just damaging to the river corridor due to the historical changes in flow regimes.

If water intercepted by feeder drains is stored and then dispersed by irrigation in the nearby landscape as soon as is opportune, the overall effect will be to reduce stormflow runoff and enhance flow-duration in streams.

Modelling of farm dams fed by feeder drains could be undertaken to help determine optimal location of dams, size, the spacing of smart culverts, size of through-pipes and culvert pipes, slopes on feeder drains, design of irrigation works and timing of utilisation of stored water. Keeping these farm dams full for a “rainy day” could be disastrous! The idea is to wet up the landscape a high as is practicable throughout. Storage should be as much in the soil as in the dams.

21 Brown Mountain Water Project (pumped hydro scheme).

This proposal is for a new storage at Steeple Flat. This is right at the top of the catchment and would have a limited catchment of its own. A better option might be to construct a much larger storage at the Crystal Brook site and use excess variable renewable energy to pump from this dam to the Cochrane dam, then generate power at the optimal price using existing infrastructure.

To get a kilowatt hour of power using hydro-electric generation, a cubic meter (1 KL) of water must fall approximately 370 meters. It makes sense to utilise the full height of the escarpment for a pumped hydro scheme.

27 Merimbula Effluent Management Scheme.

The Bega Valley Sewerage Program was a $58 million public/private partnership which began with the objective of providing reticulated sewerage to four villages and upgrading the Sewerage Treatment Plants for Bermagui, Bega and Merimbula/Pambula, with the further objective of beneficial reuse of sewerage effluent wherever feasible. It failed to produce a viable scheme for the disposal of most of the effluent from the Merimbula STP. My unhappy interactions with the process led me to withdraw from engagement for a number of years.

Work done by TESIB on the Merimbula EIS proposed some effluent disposal at the Oaklands property on the Pambula flood plain. However, the EIS contained “visual estimates” of hydrological parameters such as saturated hydraulic conductivity. Some of the ranges of this parameter said to be used in the modelling would have fallen outside the acceptable range for surface infiltration capacity for effluent irrigation prescribed by the EPA. (Merimbula Sewerage Scheme Augmentation, Part A, Volume 2, Appendix G, ERM 2005).

Subsequently, the BVSC has engaged other consultants to <u>measure</u> hydrological parameters and map soil types on the Oaklands property.

The community consultative committee appointed by the BVSC seems to have been dominated by oyster farming interests. This has led to the proposal for an ocean outfall for secondary-treated effluent, thus minimising the risk of harm to oyster production in the Pambula/Broadwater Lake but perhaps missing out on the benefits of modest organic enrichment of the aquatic environment.

At an early community consultation meeting convened by ERM on the Merimbula upgrade, the late Vries Gravenstien proposed irrigation of areas of native vegetation with sewage effluent as a buffer against bushfires. An ERM spokesperson (Ian Grey) said that most natives were intolerant of high nutrient levels. I believe this is not true for local rainforest- remnant- vegetation species.

I have proposed the use of effluent irrigation of local remnant rainforest species as the best method of beneficial reuse. Disposal out to sea seems wasteful and will require the continued expenditure on energy to pump the effluent against the water pressure at the proposed distance and depth.

Irrigation schemes to dispose of effluent require storage in order to hold the effluent in periods of wet and cold weather for later use in hot, dry weather. Storing nutrient-rich effluent in surface dams can risk the development of toxic cyanobacteria blooms. This can potentially be managed by shading with rafts of macro-algae or other aquatic plants.

Spray irrigation of nutrient rich effluent will rapidly encourage plant growth and soil formation processes. Naturally occurring soils on coastal Ordovician shales or Devonian/Silurian conglomerates are rather skeletal. However, these geologies could rapidly develop absorbent topsoils with the application of adequate and frequent spray irrigation in warm dry weather. Weeds management would be an issue so planting of a relatively gently sloping site in rows to facilitate mechanical mowing/slashing would be advisable.

The siting of a rainforest plantation to give maximum benefit for bushfire buffering and habitat creation would depend on the availability of suitable land at a reasonable distance from the existing STP. With the possibility of sea level rise threatening most coastal STPs, relocation further inland might be worth considering.

Disposal of secondary treated sewerage effluent out to sea is wasteful of freshwater and nutrient resources. It potentially risks the development of toxic microalgae blooms such as Pseudonitzchia, the cause of amnesic shellfish poisoning, as has occurred in the Wagonga Inlet, and Alexandrium, the cause of paralytic shellfish poisoning, as has occurred in Twofold Bay. The proximal cause of the Alexandrium bloom in Twofold Bay, which necessitated the suspension of mussel harvesting in the spring and summer of 2016, was probably the massive nutrient release from smashed macro algae and other marine organisms in the July 2016 "east coast low" event. The underlying cause was probably the continued release of nutrients from the Eden STP outfall. (While nutrients are mobilised from forestry and agricultural operations during significant rainfall events, these tend to be tightly bound to clay minerals also eroded at the time.)

29 Improved fish passage in South Coast Rivers.

All on-stream storages should have fish ladders or fish elevators installed where there is significant fish habitat upstream. Most native fish species are diadromous so they require the ability to migrate between freshwater and estuarine environments to complete their breeding cycles.

No new on-stream storages should be permitted without provision for fish passage.

34 Active and effective water markets.

I have never seen a credible reason why data on who holds water licenses and the conditions of such licenses is not available to the general public. Such data should be available on the internet, along with the rules for trading and the value of recent trades.

40 River Recovery Program.

As stated in the introduction, previous attempts at restoring the riverine corridor have been wrecked by major flood events such as March 2011. This is disheartening for all those involved.

Unless the hydrological regime can be restored to something resembling the pre-European invasion/settlement state, much of the effort to repair the riparian zone will be wasted.

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