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Dehydration & rehydration of the Australian landscape

Campbell Wilson, The Mulloon Institute

If you were to step back in time and join the early European explorers as they journeyed across the Southern Tablelands of NSW, it is highly likely that if you wandered onto one of the broad valley floors that are typical of the region, you would find a scene similar to that shown in Figure 1.

Figure 1: An intact swampy meadow containing a chain-of-ponds. This landscape setting was common at the time of European settlement.

These systems are commonly referred to as swampy meadows, and are typified by broad floodplains dominated by dense tussocks, sedges and rushes.

These settings have undergone significant changes in recent times, at both geological and human time scales. One of the major reasons for these changes through time is that plants are the architects and builders of these floodplain systems. As will be seen in the following sections, any major vegetation disturbance can have significant consequences for the underlying landform.

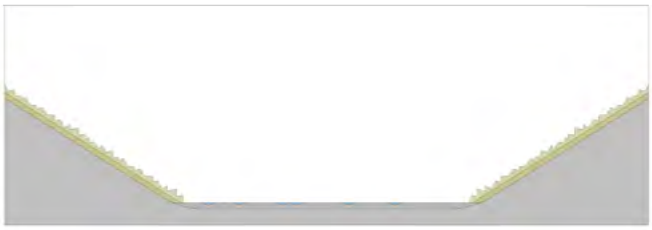
ICE AGE TROUBLES

At a geological timescale, floodplains similar to those in Figure 1 are actually quite transient features, with studies indicating that whole floodplains they have built up and washed away on multiple occasions over hundreds of millennia.

One of those occasions was during the last ice age. During this period, which finished about 12,000 years ago, Australia experienced very little glaciation other than a few spots high in the alps of NSW and Tasmania. Although this meant that valley floors weren't scraped back to bedrock by huge slabs of ice like they were in large portions of North America, Europe and Asia, the climatic influence on vegetation resulted in a fairly similar outcome for upland valley settings.

During this period, the climate of southeastern Australia was obviously colder, but it was also more arid. This climatic combination significantly reduced overall biomass and groundcover, which meant both rapid runoff from the hills and few plants present to bind and stabilise the valley floors when flash storms arrived. As a result, the extensive floodplains that had built prior to the ice age were almost completely washed away. All that remained on many of the valley floors were wide beds of alluvial gravels, with streams likely to have been braided, containing multiple criss-crossing flow pathways (Figure 2).

Figure 2: Cold and arid conditions in southeastern Australia during the last ice age significantly reduced vegetation across the landscape. Flash runoff and compromised riparian vegetation resulted, with floodplain systems of the tablelands often completely eroded back to wide beds of alluvial gravels containing braided streams.

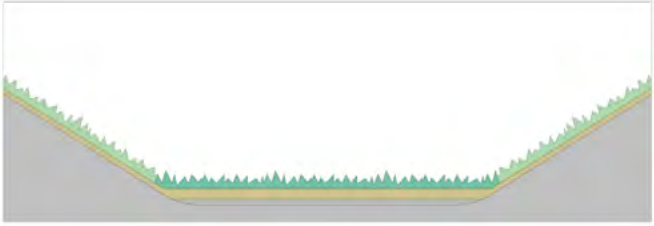


Maules Creek, NSW

PLANTS RULE THE HOLOCENE

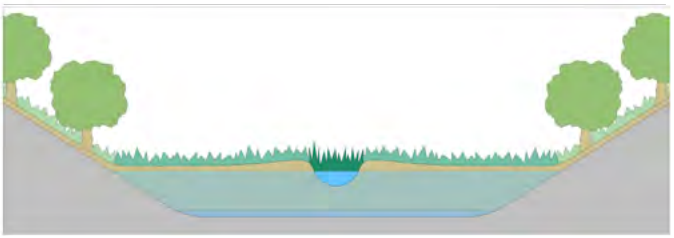
As the earth entered the Holocene just under 12,000 years ago, the warmer and moister climate of southeastern Australia became far more favourable for plant growth. The well-hydrated beds of gravels began to colonise with moisture loving plants. Anything that water rubs up against slows it down, and the roughness provided by the establishing plant systems resulted in the accumulation of fine sediments, and began raising valley floors (Figure 3).

Figure 3: Exiting the last ice age, conditions became far more favourable for plant growth with the increased warmth and moisture available. Vegetation systems colonised the gravel beds and began to trap fine sediment, raising valley floors.



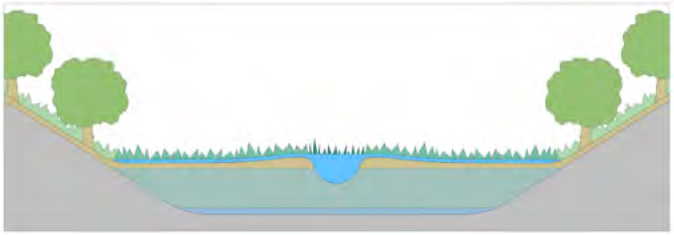
An ongoing favourable climate, in combination with consistent land management practices by Indigenous Australians, saw vegetation continue to flourish on the valley floor. The dense tussock and sedge that typify swampy meadows (Figure 1) helped to slow flow and capture even fine sediment, continuing to vertically build fertile soils over time. The considerable flow-resistance within an intact swampy meadow helps to store moisture within the floodplain aquifer, and as a result the watertable is often close to the surface. If a chain-of-ponds is present, this provides a window of insight into the proximity of the watertable to the surface (Figure 4).

Figure 4: Dense vegetation helps to vertically build sediment and store moisture within the floodplain aquifer, with watertables commonly close to the surface.



If channels are present, they tend to be shallow and discontinuous. The dense vegetation flanking these channels, and surrounding ponds if they are present, ensures that if a major runoff event does occur, there is considerable resistance present. This slows the flow, causing it to rise and spill its banks, spreading into a passive sheet across the floor of the floodplain (Figure 5).

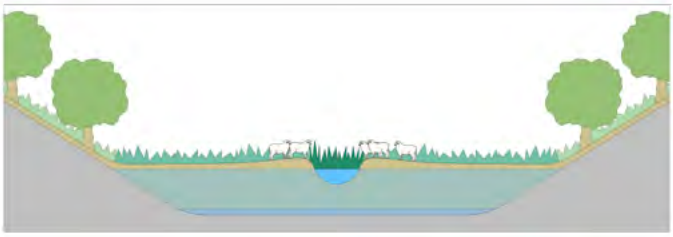
Figure 5: Dense riparian vegetation helps to slow flow, causing it to spread into a passive sheet across the floor of the floodplain.



EUROPEAN IMPACTS ON A FRAGILE LANDSCAPE

The extensive native grasslands that existed at the time of European settlement were a product of the skilled and deliberate use of fire by Indigenous land managers. These grasslands were particularly attractive for sheep production, and chains-of-ponds fed by the alluvial aquifers offered a consistent water supply (Figure 6).

Figure 6: The extensive native grasslands that existed at the time of settlement as a result of skilled indigenous land management were ideal for the development of pastoralism.



The imposition of a range of European land management practices on the older and more fragile Australian landscape had significant hydrological impacts. In particular, the clearance of woody perennials and overgrazing of native pastures due to the proliferation of both domestic livestock and feral animals, resulted in a considerable increase in surface runoff. Vegetation on valley floors was also severely affected by grazing, the impact of hard hooves that were previously absent, and deliberate drainage for cropping and parasite reduction purposes (Figure 7).

The combination of increased runoff and streamflow, reduced flow resistance and less stabilising-vegetation resulted in severe and widespread gully erosion like no other time in the last 10,000 years (Figure 8). When a gully forms, it drains the adjacent floodplain aquifer, dropping the watertable down to depth of the new gully floor (Figure 9). Once this occurs, not only is the vegetation on the floodplain surface now at the mercy of

our erratic rainfall patterns, even the largest streamflows are commonly fully contained within the channel, without any surface interaction (Figure 10).

Figure 7: The imposition of a range of European land management practices severely impacted vegetation within a few decades of settlement. The concentration of hard hooved livestock around waterholes particularly impacted vegetative cover in these settings.

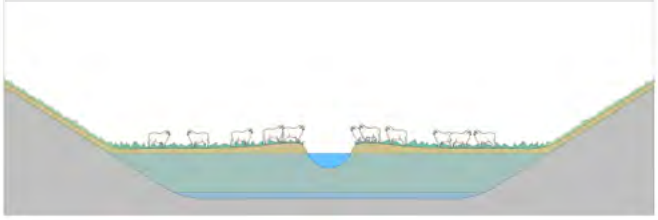


Figure 8: The combination of increased runoff (due to reduced perennial vegetation and severely grazed groundcover) and reduced flow resistance and soil binding root systems on the valley floors, resulted in the widespread incision of swampy meadows.

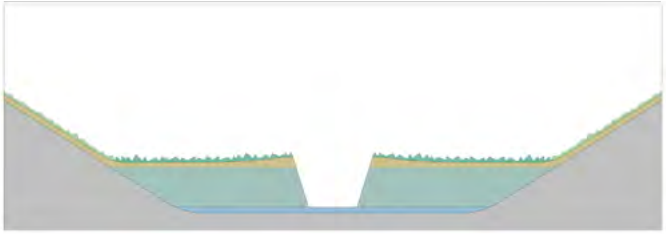
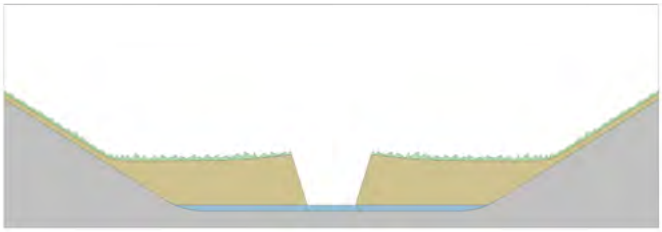
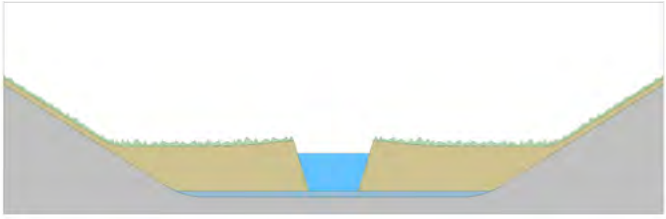


Figure 9: Newly formed gullies acted as drains for the floodplain aquifers, dropping the watertable to the depth of the channel floor.



River bank erosion

Figure 10: Within an incised system, even large flows are commonly contained within the channel, resulting in very little interaction of moisture or fertility with the surrounding landscape.



JUST ADD WATER

In recent times, there has been a growing understanding of the range of functions and resilience that intact swampy meadows can bring to our harsh climate and old landscapes. Landholders have been particularly interested in the way they act as a sponge and help to buffer drought conditions both locally and at a catchment scale. This has led to landholders installing series of structures within incised channels to reinstate some of the old geomorphic, hydrological and ecological patterns and processes.

An example of this sort of work can be seen in the before and after images in Figure 11 & Figure 12 respectively. These photos are taken at Peter's Pond, one of the structures at the base of a 3 km long riparian restoration project on Mulloon Creek Natural Farms, near Bungedore, NSW. This project was initiated by The Mulloon Institute, with the work overseen by Peter Andrews, the founder of 'Natural Sequence Farming'.

Figure 11: A view towards Peter's Pond in 2006 before work commenced shows eroding banks and minimal vegetation on the site.

Figure 12: The construction of Peter's weir under the trees in the distance formed a considerable backwater, resulting in a marked increase in both aquatic and terrestrial biomass. This photo is the same orientation as Figure 11.

The pools that are associated with the series of structures, often weirs constructed from rocks, logs and stabilising vegetation, increase the hydraulic gradient and result in recharge of the adjacent floodplain aquifer (Figure 13), raising the watertable over time (Figure 14). The increased moisture available to plants on the floodplain surface, as a result of the watertable being to the surface, can result in a considerable increase in primary production on the floodplain surface. The increased vegetation within the channel and on the banks (Figure 12) also enhances the roughness and flow resistance along the system, and provides more opportunity to trap sediment and organic material.

This biomass can be periodically harvested and utilised elsewhere on the property to boost fertility and production.

Figure 13: Weirs installed within the incised channel form pools on the upstream side, resulting in recharge of the adjacent alluvial aquifer.

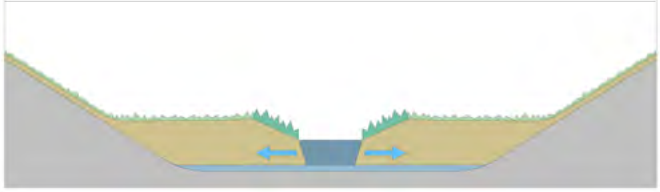
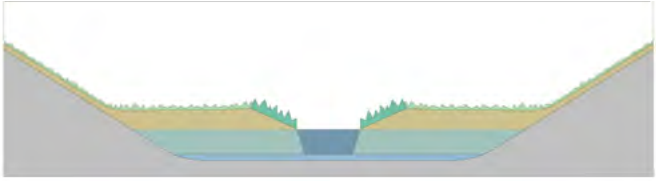


Figure 14: Over time, the watertable within the alluvial aquifer will tend to correlate closely with the level of structures, while increased biomass helps to slow flow and improve water quality and aquatic biodiversity.



The academic article "Sustainable water and energy management in Australia's farming landscapes' relates to this summary.

the mulloon institute
for environment, farming and society

The Mulloon Institute is a not-for-profit research, education and advocacy organisation that demonstrates, monitors and shares innovative approaches to regenerative land management.

The vision of the Mulloon Institute is to support the rebuilding of a resilient Australian landscape which produces the water, soil and biodiversity required to produce food and water security for the Australian population in the short and long term by working with landowners.

Land and water management strategies are aimed at rebuilding landscape function and resilience by rehydrating a landscape that has been dehydrated by 200 years of soil erosion and loss of organic matter by:

- rebuilding soil fertility
- fixing more carbon in the landscape
- restoring lost biodiversity
- improving water quality and availability
- moderating climatic extremes.

This result will be increased agricultural productivity, production of high quality nutrient dense food and improved human health and community cohesion.

To learn more:

- Visit the Mulloon Institute website – https://themullooninstitute.org
- Listen to Luke Peel speak about *Landscape dehydration and rehydration* on this link to his presentation at the GTA NSW & ACT Annual Conference 2019 – https://vimeo.com/334802339/b0c2e9baac