FACT SHEET 11

Managing phosphorus in catchments

RiverLandscapes

This Fact Sheet is the eleventh in a series dealing with the management of rivers and riparian land.

Phosphorus is an essential component of all plants and animals, and is a natural part of the rocks that comprise the earth's crust. While phosphorus is a natural and vital nutrient in our ecosystems, changes in landuse (e.g. intensive agricultural development) have radically altered the amounts of phosphorus being delivered to our waterways, particularly river courses, reservoirs and lakes. Excessive nutrient loads in these water bodies can cause eutrophication, a process leading to deteriorating water quality and the increased occurrence of toxic and unsightly algal blooms such as blue-green algae (*cyanobacteria*).

There is a close relationship between how land is managed and the impact phosphorus may have on in-stream health. In order to manage Australian waterways effectively, we need to determine the relative importance of the various sources of phosphorus, as well as understand the processes by which phosphorus is delivered into our rivers. Knowledge about how and why phosphorus gets into waterways can help land and water managers make better management decisions.

Sources of phosphorus in Australian catchments

Phosphorus enters our rivers and estuaries from a number of different sources. The relative significance of each source varies from place to place, depending upon factors such as land use, geology, population density, rainfall intensity and erosion.

Sources of phosphorus include:

- 'point' sources such as sewage treatment plants, intensive animal industries, and irrigation and stormwater drains; and
- 'diffuse' sources such as soil and fertiliser runoff, and phosphorus-rich soils from eroding gullies.

As a general rule, point sources are often believed to be the major contributor of phosphorus to waterways in urban environments. Diffuse sources dominate in rural environments, with agricultural fertilisers and animal effluent generally perceived to be the major sources of phosphorus entering rivers in these areas.

Above: Intensive irrigation and stormwater drains are point sources of phosphorus.
Photo Peter Hairsine.

Right: Soil and fertiliser runoff from cultivated paddocks are diffuse sources of phosphorus.
Photo Peter Hairsine.

On steeply sloping cleared land the transport of phosphorus into our river systems is significantly increased.
Photo Peter Hairsine.

It has been now been shown that the biggest contributor of phosphorus in Australian catchments is from diffuse sources, and is strongly associated with soil erosion.

However, research in Australia suggests that only where there are high population densities and intensive agriculture do we see strong evidence that phosphorus comes directly from sewage, fertilisers and animal wastes. It has now been shown that the biggest contributor of phosphorus in Australian catchments is from diffuse sources, and is strongly associated with soil erosion. This is because changes in land use have altered diffuse nutrient loads by increasing soil erosion rates. Increased soil erosion results in significant increases in the transport of naturally derived nutrients, such as phosphorus, into our waterways.

The amount of phosphorus available for transport to our waterways will depend upon:

- the geology of the catchment,
- the overlaying soils and their natural phosphorus concentrations,
- landuse type and intensity, and
- the nature and magnitude of the erosion process.

Natural phosphorus refers to the amount of phosphorus present in the soil naturally. Some rocks, such as basalts, have naturally high amounts of phosphorus. The weathering and break down of different rock types results in varying amounts of natural phosphorus being present in the overlying soils. When these soil types are cultivated, increased gully erosion can occur, delivering large amounts of phosphorus into our river systems.

Natural phosphorus is also referred to as native P.

Gully and streambank erosion can contribute phosphorus into our rivers. Photos Ian Rutherfurd.

Phosphorus and the erosion process

Phosphorus moves through the landscape either dissolved in water, or attached to soil particles (particularly fine clays) that are carried along by the water. Soil eroded from the surface of hillslopes, or from the beds and banks of gullies and streams, can also carry phosphorus to streams.

Surface 'sheet' or rill erosion can produce clay rich sediments that are often high in phosphorus. This kind of surface erosion is especially important to manage in areas with high rainfall intensities (such as the tropics in northern Australia) and where soils are intensively tilled. Over 85% of the sediment-bound phosphorus in Far North Queensland is derived from hillslope erosion of surface soils.

In other areas, subsurface erosion may dominate and phosphorus will be released primarily through gully erosion and the erosion of stream banks. Approximately 50% of the sediment-bound phosphorus in the Murray-Darling Basin and other catchments in New South Wales and Victoria is derived from a combination of gully and channel erosion. Subsoil phosphorus concentrations are generally lower than surface soils, but the phosphorus from this source often dominates because of the greater mass of sediment eroded from gully erosion and channel collapse on floodplains.

In parts of the Murray-Darling Basin where gullies are widespread, most of the soil bound phosphorus is washed from the gullies during large storms. The phosphorus in these gullies is naturally occurring and normally not influenced by fertiliser application. Although the worst of the gully erosion occurred decades ago, active gullies still continue to add phosphorus to our river systems.

Broadly speaking, catchments with a high drainage density (length of stream per unit area of catchment that can be increased through extensive gully development) and high natural phosphorus concentrations (due to geology and soil type), will generate high sediment yields and total phosphorus. A significant amount of the phosphorus will be derived from erosion within the channels. In contrast, catchments with low drainage density and low natural phosphorus will have low overall sediment and phosphorus entering rivers. Under these conditions, a greater proportion of this material will be delivered from surface erosion.

The role of phosphorus in algal blooms

With increasing understanding of the processes that cause algal blooms, managers are aware of the importance of controlling nutrients that enter waterways via erosion and run-off. With respect to blue-green algae, most attention has been given to the role of phosphorus in promoting outbreaks of the bacteria.

Nutrients, particularly phosphorus and nitrogen, are essential for the development and growth of algal blooms. Other conditions include warm weather, still water and light. While algae are a natural part of ecosystems, when the conditions are right and there's an excess of nutrients in the water, the algae can multiply at extraordinary rates and cause serious problems, for example, making the water unsuitable for consumption by humans or animals. More information about managing algal blooms can be found in Fact Sheet Ten of this series entitled 'River flows and blue-green algae'.

Algal bloom sign at an urban lake. Photo Kay Morris.

Increased nutrients entering rivers can cause algal blooms. Riparian vegetation can help reduce the amount of sediments and nutrients entering rivers. Photo Ian Prosser.

Beware of 're-cycling' phosphorus

Sediments are intricately linked to both the supply and transfer of phosphorus. Managing diffuse sources of sediment and phosphorus is a key priority for land managers in controlling phosphorus delivery to streams. Recent research has also discovered the significance of existing stores of sediment in supplying nutrients for algal growth. Previous episodes of erosion and transport have delivered phosphorus to our waterways, with the phosphorus rich sediment being stored at the bottom of riverbeds and in shallow lakes. Research has shown that phosphorus release from low-oxygen sediments in riverbeds is an important factor in the on-set of some major algal bloom outbreaks.

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Depending on the conditions, the sediments of shallow aquatic systems are important sources of nutrient regeneration, as well as acting as temporary or near-permanent sites of nutrient storage (sinks). Sediments can act as phosphorus sinks under aerobic (oxygen rich) conditions because oxygen is freely available to the microbes (bacteria) living in the sediment. Microbes affect the release of phosphorus through their respiration, and this reduces oxygen concentrations in bottom waters during periods of temperature stratification (layers in the water column — warm on top and cooling with depth). This process also occurs when there are high organic loadings (e.g. dead and rotting plant matter) in the water.

Phosphorus-rich sediment stored in the bottom of rivers or reservoirs is considered in the long term as a source for algal blooms. Studies suggest that 60% of the phosphorus load that reaches our river systems may end up deposited on floodplains, and 13% will be stored in reservoirs with fine sediment. The release of phosphorus from these sources will potentially be greatest in catchments such as the Murray-Darling Basin where a large number of reservoirs and shallow lakes exist. This requires the development of long-term management strategies so that the re-release of nutrients such as phosphorus and nitrogen from these sinks is controlled.

Management practices to control phosphorus transfer to streams

Most phosphorus is transported attached to particles of soil. This means that management practices developed to minimise or intercept erosion (whether surface or subsurface) are also likely to minimise phosphorus transport. The following management practices can help reduce the generation and delivery of phosphorus in our catchments.

- Focus on controlling diffuse sources of phosphorus (e.g. such as streambank and gully erosion) that contribute a substantial proportion of sediment and phosphorus.
- Stabilise stream banks and control stock access to reduce the risk of bank collapse.
- Develop engineering structures (e.g. contour banks, gully sediment traps, artificial wetlands, farm dams) to reduce on-site erosion and sediment delivery.
- Manage erosion in high flow events to control the transport of phosphorus to downstream river reaches and other receiving waters.

Manage grazing and stock access to limit erosion of soils and groundcover destruction. Photo Peter Hairsine.

Riparian strips control the delivery of diffuse sources of nutrient by trapping and filtering sediment and stabilising stream banks. Photo Peter Hairsine.

This cane farmer has created an artificial wetland to trap nutrient runoff from entering the nearby river system. Photo Ross Digman.

- Develop practical methods to reduce flood peaks and volumes by building appropriate conservation structures such as surface retention basins to store upland rainfall in the landscape soils and by managing ground cover during wet seasons.
- Time pasture management (e.g. topdressing, pasture improvement) to limit the transfer of phosphorus-rich soils to streams.
- Manage grazing (e.g. stocking rate and intensity) to limit erosion of soils due to stock tracks, groundcover destruction and excess surface erosion.
- Provide stock watering and shade away from drainage lines to limit destabilisation and erosion of stream banks.

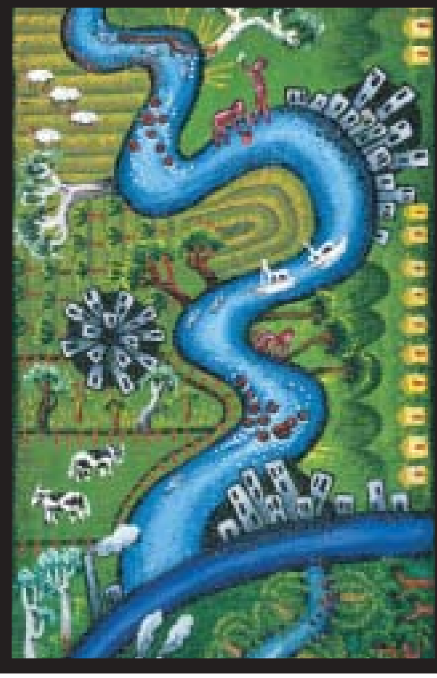
For further information

To see recent predictions of nutrient loads delivered to streams and reservoirs in your catchment, log onto the Australian Natural Resources Atlas at www.nlwra.gov.au

All statistics in this Fact Sheet are from the Australian Natural Resources Atlas, 2000, National Land & Water Resources Audit, Canberra.

FACT SHEET 11
BACK PAGE

These **Fact Sheets** are grouped according to whether they deal with riparian land, in-stream issues, river contaminants or other matters. They aim to set out the general principles and practices for sound management. Other information that focuses on local conditions and management issues is available from state government agencies, local governments, catchment management authorities, rural industry bodies and community organisations. Together, this information should assist users to understand the key issues in river and riparian management, and enable them to adapt general management principles to their particular situation, and to know where to go for advice specific to local conditions.



Other relevant Fact Sheets

Fact Sheets 10 and 11 are largely based on work conducted in the former National Eutrophication Management Program.

Further information on river and riparian management can also be found at the Land & Water Australia 'River Landscapes' website.

www.rivers.gov.au

This website provides access to projects, fact sheets, guidelines and other information designed to assist people to better manage river and riparian areas across Australia.

RiverLandscapes

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