Australia's rivers

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By world standards Australia is a dry continent with few freshwater resources. Australian rivers are characterised by relatively low and variable flows.

In much of the intensive land use zone of Australia, catchment land use has significantly modified the physical and chemical nature of the rivers. These now carry higher than natural levels of sediment and nutrient. In some regions, the biological condition of the rivers, wetlands and groundwater dependent ecosystems has been severely impacted by the extraction of large volumes of water for agricultural, urban and industrial use.

It is widely recognised that the condition of many of Australia's rivers has declined below a level that the broader community considers satisfactory. The states, with Federal Government support, are acting to improve catchment management and reduce the ecological pressures associated with high levels of abstraction.

Variability — a characteristic of Australia's rivers

Rainfall is distributed unevenly, both geographically and seasonally, across Australia. In vast areas the average annual rainfall is less than 200 mm/year, while in parts of north eastern Queensland and western Tasmania rainfall exceeds 3,000 mm/year. Most of this rainfall, even in the wetter catchments, does not run off into the river systems. On average, only 12% (less than 3% in the drier areas and up to 24% in the wetter areas) of rainfall enters the rivers; the remaining rainfall is accounted for by evaporation, used by vegetation or stored in lakes, wetlands and groundwater aquifers. Almost 50% of Australia's average annual run-off enters the Gulf of Carpentaria, a region of relatively limited water resource development, and the Timor Sea (NLWRA 2001b).

Driven by a changeable climate, variable river flow is a characteristic of Australian rivers. Flow variability can be described by the coefficient of variation of annual flows (CVR), calculated as the standard deviation divided by the mean. Australia and South Africa have CVR well in excess of the world average (Finlayson & McMahon 1988). While this relationship is true for all catchment sizes, it is particularly so for Australia's large (greater than 100,000 km^2) inland catchments, which have a CVR of 1.12, nearly four times the world average of 0.33. As well as more variable flow, extreme floods occur more often in Australia and South Africa than in the rest of the world (Finlayson & McMahon 1988).

Highly variable flows have important implications for river management as the flora and fauna of Australia's rivers have evolved with this variability. River regulation by dams reduces the numbers and extent of floods and dry periods, and reduces water quality. These changes affect the way the river functions physically and chemically, in turn impacting on the plants and animals living there.

The high run-off variability and extreme flood pattern influence the size and type of Australia's major dams. The level of demand and reliability expected by Australian water users, combined with the high levels of evaporation in Australia, has led to Australia's relatively high storage volumes. Australia's large dam storage capacity of 79,000 GL (in 447 large dams) is four times annual surface water diversions of 19,100 GL (NLWRA 2001b).

Pressures on the rivers

The consumption of Australia's freshwater resources from lakes, rivers and underground aquifers has increased dramatically in the last two decades. Between 1983–84 and 1996–97 national water consumption increased from 14,600 GL to

23,300 GL (NLWRA 2001b). Of the water diverted in 1996–97, approximately 75% was used for irrigated agriculture (17,356 GL), 5% (1,238 GL) for other rural purposes such as stock and domestic uses, with the remaining 20% (4,673 GL) for urban and industrial purposes (NLWRA 2001b).

Irrigated agriculture is by far the biggest consumer of Australia's freshwater resources. In return, major economic and social benefits accrue to Australia from irrigated agriculture. Without irrigation, a significant proportion of Australia's agricultural industries would either not exist or would be greatly diminished. Towns and industries that rely on these enterprises would contract or disappear. Total annual profits from irrigated agriculture averaged over the five years to 1996–97 were $3.84b, accounting for over 50% of the total profits from Australian agriculture (NLWRA 2002b).

Across Australia, catchment land use and diverting water are considered the most serious threats to the ecological condition of Australia's rivers, wetlands and groundwater dependent ecosystems. Determining a sustainable level of diversions (sustainable yield) to support either rural, urban or industrial use is complex. It inevitably requires a trade-off between environmental, cultural, social and economic values. Each state and territory government has developed its own methods for estimating sustainable yield. The relative weighting given to various social, environmental and economic values reflects local knowledge and values. As would be expected, the weightings given to these values are often highly contentious.

Based on state assessments of sustainable yield the Audit (NLWRA 2001b) determined that 34 (10.5%) of Australia's 325 surface water basins are overused, with a further 50 (15.4%) highly developed. On the other hand, 60% of Australia's river basins have less than 30% of the nominated sustainable flow regime diverted (NLWRA 2001b). Almost all of the basins with a high volume of unused sustainable yield are in the northern parts of Australia. Undoubtedly, these regions will be heavily targeted for water resource development in the future, and long-term planning for this needs to be undertaken so as to avoid the mistakes made in many of the southern water basins.

Land use in the catchment, combined with how well this use is managed, is a major driver of river condition. Approximately 60% of the Australian continent is used for agriculture, predominantly cropping and grazing (NLWRA 2002b). In the non-urban regions, most of the elevated nutrient and sediment loads to rivers are a consequence of using land for agricultural production. High fertiliser application rates, and other agricultural practices, have resulted in some landscapes leaking more nutrients into the waterways than they did before the adoption of European agricultural production systems. Attention to management of on-farm nutrient balances should reduce the leakage of nutrients into Australian rivers (NLWRA 2001a).

Widespread clearing, particularly of the riparian vegetation and in areas vulnerable to soil erosion, results in higher than natural sediment loads to many rivers. Increased sediment loads smother important habitat for aquatic biota, for example, deep holes in rivers that provide important refuges for many native fish and other biota are frequently filled in. Increased sediment loads also increase turbidity, resulting in reduced aquatic plant growth and increased costs of water treatment. The Audit estimates that a 5% increase in turbidity of Australian streams will increase water treatment costs by $715m over the next 20 years (NLWRA 2002b).

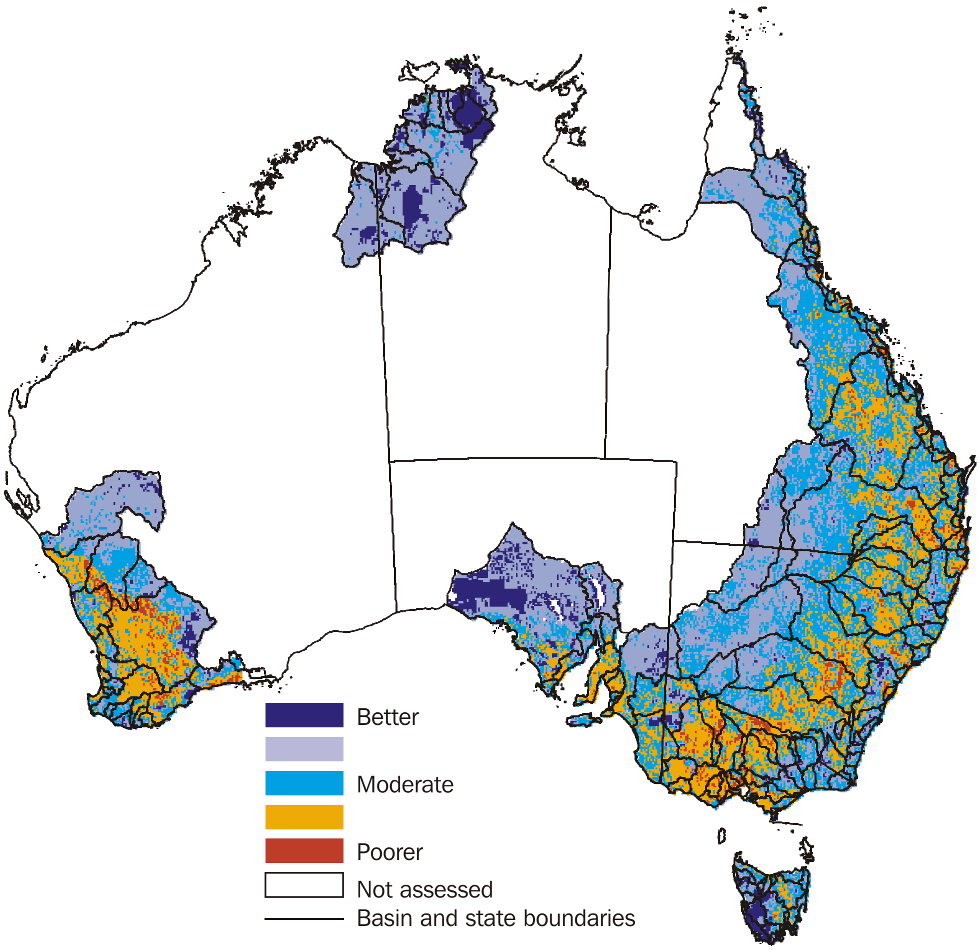
River condition depends on catchment condition

Use of Australia's land and water resources places pressures on the river systems. The Audit describes the impact of these pressures on the condition of Australia's rivers (NLWRA 2002a).

The Audit reports catchment condition across Australia using an index composed of 14 sub-indices that describe attributes of the catchments, land, water and biota. The differences in the condition between catchments were described by a few indicators: vegetation cover, native vegetation fragmentation, sediment and nutrient inputs to rivers, catchment hydrology (particularly the effects of dams), and land use intensity (NLWRA 2002a). The catchments in the poorest condition were in areas with intensive land use. These catchments are generally in cleared, agronomically marginal rainfall areas that have soils of relatively poor fertility and structure (map S14.1) (NLWRA 2002a). Until the condition of these catchments is significantly improved, we should expect that river condition in these catchments will continue to decline.

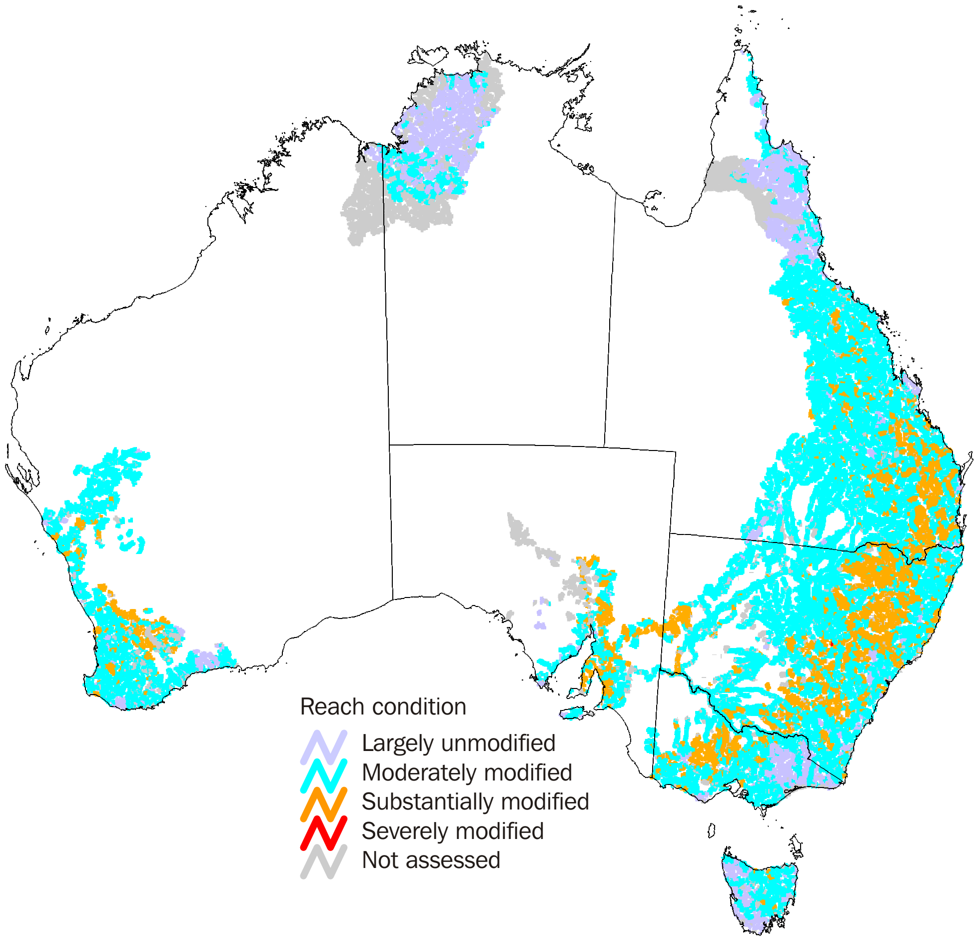
The Audit (NLWRA 2002a) describes river condition using an environmental index that combines the effects of catchment disturbance, habitat condition, hydrological disturbance, and nutrient and suspended sediment loads. The environmental index shows that within the intensive land use zone of Australia, which represents approximately 40% (3 million square kilometres) of the continent, over 85% of the rivers have been degraded to some extent by human activity (map S14.2). The percentage of river significantly modified, ranges from 97% of river length in New South Wales rivers to 34% in Northern Territory (NLWRA 2002a).

S14.1 CATCHMENT CONDITION FOR 5 KM x 5 KM CELLS



Source: National Land and Water Resources Audit Assessment of Catchment Condition 2002 Database.

S14.2 CONDITION OF RIVER REACHES BASED ON THE ENVIRONMENT INDEX



Source: National Land and Water Resources Audit Assessment of Catchment Condition 2002 Database.

The Audit reports a relatively high correlation between catchment condition and river condition as described by the Environment Index (NLWRA 2002a). While these indices are not entirely independent, the strong correlation underscores the need to consider broad catchment management as part of any river management program.

The rivers are carrying more nutrient and sediment

Australia's history of agricultural practices has resulted in an accelerated leakage of nutrient and sediment from Australian landscapes. The Audit (NLWRA 2002a) reports that nutrient and suspended sediment loads to be significantly higher than natural levels for 92% of river length (map S14.3). Total phosphorus (TP) loads in rivers averaged 2.8 times higher than estimates for pre-European settlement levels and total nitrogen (TN) loads are 2.1 times higher (NLWRA 2001a). Exceeding national guidelines for nutrient concentrations is a major concern in 61% of river basins (NLWRA 2001b).

The dominant sources of TP and TN to the rivers vary depending on the local climate, geography, geology and land use. In Queensland and New South Wales, hill-slope erosion dominates, while in coastal Victoria, South Australia, Western Australia and Tasmania, river bank erosion and dissolved phosphorus run-off dominates. TN loads come predominantly from hill-slope erosion in Queensland and coastal New South Wales, and as dissolved run-off in coastal Victoria, South Australia, Tasmania and much of Western Australia (NLWRA 2001a). Most nutrient and sediment entering the waterways are deposited on floodplains. Of the TP entering the waterways, 60% is deposited on floodplains, 13% in reservoirs and 27% reaches the coast. Of the total TN entering the river systems, 41% is deposited on floodplains, 9% stored in reservoirs, and 39% reaches the coast. The remaining 11% is converted to nitrogen gas and lost to the atmosphere.

Accumulation of sand and gravels is a major stressor in many Australian streams. Extensive delivery of sediment to the rivers occurs downstream from areas of hill-slope erosion (50 million tonnes per year), gully erosion (44 million tonnes per year) and streambank erosion (33 million tonnes per year) (NLWRA 2001a). Most of the sediment supplied to rivers is deposited in channels, floodplains and reservoirs, with about 20% entering the ocean (NLWRA 2001a).

About 30,000 km of river length have experienced sediment accumulation of greater than 0.3 metres since European settlement. The Murray–Darling Basin is one of the worst affected basins, with 20% of river length accumulating more than 0.3 metres of sediment. Land management that targets erosion control could provide a significant benefit to managing supply sediment loads and nutrient loads to many rivers.

The rivers have less water

Assessing the impact of human activities on the flow regime of Australia's rivers is complicated by the relative lack of suitable hydrological information. The Audit found adequate information on which to determine natural flows for only 30% of the total river length in Australia's intensive land use zone (NLWRA 2002a).

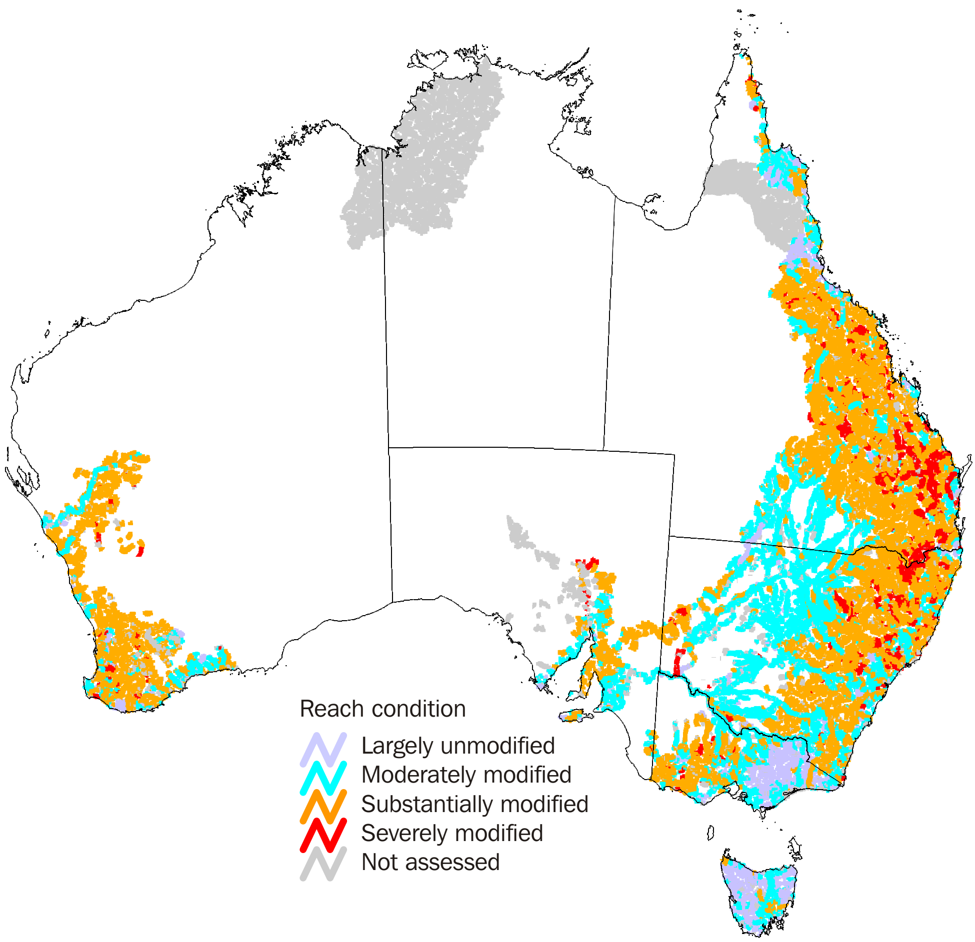
Rivers below major dams, termed regulated rivers, generally flow for longer periods than natural, and the seasonal variability in flows is reduced (NLWRA 2002a). There are fewer small floods and dry periods and there is frequently a reversal of seasonal flows, such that water is retained in the dams during the wetter periods and rivers run high during the dry periods to supply irrigation water.

Less is known about the level of hydrological disturbance in rivers which do not have major dams above them. Flow is frequently reduced by abstraction, particularly during the low flow periods, but estimates of this are generally crude and are usually made on an annual or seasonal basis (NLWRA 2002a). Large-scale harvesting of floodwaters occurs in some river systems, where private floodplain storages can capture a significant proportion of flow. For example, there is significant floodplain harvesting on the Balonne floodplain. Total water storage on the Balonne floodplain is estimated to be 1,160 GL, which is equivalent to the current mean annual flow in the Balonne River (Whittington et al. 2002).

Aquatic animals reflect river and catchment use

Across the world there has been a trend toward using assessments of the condition of biotic communities to assess river condition. It is argued that the plants and animals dependent on a river will integrate the effects of environmental degradation and of pollution and are therefore the fundamental indicators of river condition (Norris & Thoms 1999). While there are many biological indicators that could be used, there are very limited data for most of them. The most comprehensive data set for aquatic biota is the information from the National River Health Program (NRHP). This program assessed river health using aquatic macroinvertebrate communities at approximately 6,000 sites across Australia, and provides the most comprehensive assessment of biotic river health available across Australia.

S14.3 CONDITION OF RIVER REACHES BASED ON THE NUTRIENT AND SUSPENDED SEDIMENT LOAD INDEX



Source: National Land and Water Resources Audit Assessment of Catchment Condition 2002 Database.

Based on data from the NRHP, the majority of rivers (69%) across Australia were found to be in good condition (NLWRA 2002a). The remaining 31% were suffering for some degree of impairment, ranging from mild impairment where some of the animals normally occurring in a river were missing, to major damage where most animals were missing. The rivers with biota in good condition tended to be in national parks, mountainous regions or remote regions. Rivers showing impact tended to be close to major cities or in highly developed agricultural areas. Also impacted were rivers in mountainous regions affected by river regulation.

The environmental factors most significantly impacting on river biological condition were poor water quality, damaged habitat, changed hydrological condition or a combination of these factors. Regions such as the Murray–Darling Basin, with considerable river regulation associated with intensive agricultural development, tended to have poor biological condition brought on by environmental degradation across multiple factors (NLWRA 2002a).

Biological data do not always give the same picture on river condition as do environmental data. In part this is attributable to the limits of one group of the biota to reflect the full range of environmental changes that can occur. Fish or algae may be better indicators for some environmental impacts. However, in many instances, a more important reason for the mismatch between biological and environmental assessments is the timelag between environmental damage occurring and its biological consequences. It may be months or years before the full impact of a change in river flows or in salinity is realised by the biota. In these circumstances the degraded environmental condition can act as an early warning of the biological damage that will occur unless restoration measures are undertaken.

Protection of freshwater ecosystems

Australia has a poor record of managing aquatic habitats. Responsibility for land and water management lies with the states and territories, though the Federal Government has been a substantial source of funding for water resource development and more recently, rehabilitation. Within most states there has been considerable activity to provide adequate flows for the environment. This has been largely driven by the Water Reform Agenda of the Council of Australian Governments, which states that the environment be recognised as a legitimate user of water, and that each jurisdiction formally determine allocations for the environment. However, despite considerable activity, progress has been slow. As at June 2000, only 43 (13%) of Australia's 325 river basins have formal allocations of flow to the environment (NLWRA 2001b).

Conservation of Australia's ecosystems has historically focused on protection of terrestrial ecosystems. Within the 7.8% of Australia's total land area that is within formally protected areas, some native terrestrial ecosystems are well protected and others are not (NLWRA 2001c). Recent efforts to increase the comprehensiveness of protected ecosystems have prioritised bioregions that have relatively low levels of protection using the Interim Biogeographic Regionalisation for Australia (IBRA) framework. While the IBRA bioregions are an accepted landscape framework for conserving terrestrial biodiversity (Cresswell & Thomas 1997), they are unlikely to be an appropriate framework for conserving aquatic biodiversity. If aquatic ecosystems fall within existing reserve systems, such as parts of the Australian Alps and south-west Tasmania, they can be adequately protected. However, this is not usually the case, and therefore frameworks that explicitly address the diversity of aquatic ecosystems need to be developed. Such a framework has been proposed by Davies (2001), which provides for the establishment of a freshwater and estuarine reserve system based on the principles of comprehensiveness, adequacy and representativeness, (CAR reserve system) in a similar way to that described for forest reserves (JANIS 1997). This is currently being implemented in Tasmania.

Like rivers, wetlands are not adequately protected. It is estimated that since European settlement approximately 50% of Australia's wetlands have been converted to other uses. In some regions the rate of loss has been even higher (Commonwealth of Australia 1997). Of those remaining, many are threatened by water abstraction, weeds and grazing. The Federal Government has a published a Directory of Important Wetlands in Australia (Environment Australia 2001). The directory describes 851 wetlands (totalling 57,829,522 ha) of national importance, but protection of these is highly variable. Of these wetlands, 57 wetlands, with a total surface area of 5,310,179 ha, are designated to the List of Wetlands of International Importance of the Ramsar Convention, referred to as Ramsar wetlands. Once listed as a Ramsar wetland, the Federal Government must ensure that the wetland is managed such that its ecological character is maintained. However, the protected status of many of Australia's Ramsar wetlands is compromised because protection does not extend to the source of the wetland's water. For example, as a result of water abstraction upstream, median annual flows to the Ramsar listed Narran Lakes in northern New South Wales have been reduced to approximately 24% of natural, and the interval between significant flooding events has been reduced from 2 years to 6.5 years (Whittington et al. 2002). It is argued that without significant alterations to water management upstream of Narran Lakes, the current level of diversion will result in a significant reduction in the health of the Narran Lakes system (Whittington et al. 2002).

There is growing recognition of the value of the few relatively unimpacted rivers in Australia (Cullen 2002). However, efforts to protect these aquatic systems are limited (Cullen 2002). Morton et al. (2002) have called for the establishment of a system of heritage rivers to protect the remaining relatively undamaged rivers. Cullen (2002) argues that the extraction of water is the major threatening process in these rivers and must be controlled.

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