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INQUIRY INTO ADEQUACY OF WATER STORAGES IN NSW

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Inquiry into the adequacy of water storages in NSW

By the: Australian Wetlands, Rivers and Landscapes Centre, University of NSW

SUMMARY

- Environmental water requirements are essential for maintaining function and health of aquatic ecosystems. Healthy aquatic ecosystems provide valuable services such as water filtration, recreation and fisheries, are globally worth an estimated $15 trillion each year. Environmental water requirements are inadequately represented in current water management. This has resulted in insufficient water availability, resulting in widespread decline of ecosystem health.
- There is widespread scientific evidence from Australia and around the world of the significant costs of building dams on downstream communities and ecosystems.
- Further expansion of dams or increasing their capacity will continue to have significant impacts on ecosystems, including rivers, wetlands, floodplains and estuaries. It will also affect communities reliant on ecosystem services delivered by rivers.
- Proposals for new storages need to be carefully considered and assessed to determine long-term costs and benefits. The cost of building new dams and losing these ecosystem services is greater than short term benefits.
- Optimal water management systems make the best use of water available for multiple objectives, including agricultural, urban, industrial and environmental sectors.
- There is currently considerable focus on the ‘supply-side’ of the equation for providing water to industry, agriculture and urban communities. It is critically important to consider the ‘demand-side’ and reduce NSW’s per capita water-use.
- There are many innovative ways for improving efficient use of water without building new storages or increasing the capacity of water storages in NSW.
- New storages and increasing capacity of current storages will impact on agricultural lands or other public lands, have significant ecological impacts downstream that occur over decades or more and will affect communities reliant on the ecosystem services delivered by rivers.
- Australia has the second highest per capita use of water each year, mostly for irrigated agriculture. There is a need to improve Australia’s efficiency of water use.

Terms of Reference

a. ***The capacity of existing water storages to meet agricultural, urban, industrial and environmental needs;***

Dams in NSW provide water for industrial, urban, agricultural and irrigation needs but there are long-term ecological and socioeconomic costs. Such costs were clearly defined in a global review of the impacts of dams[33]. Australia has the largest dam per capita dam storage in the world, with NSW alone having 144 large reservoirs with a capacity greater than 1000ML[12]. Australia also has the second highest per capita use of water each year, mostly for irrigated agriculture[10]. The current capacity of dams is mainly stored for irrigated agriculture, with 90% water stored in the Murray-Darling Basin being used for irrigation[1]. From the late 1950's until the early 1990's, there was an expansion of dams in NSW[12] and water diversions for irrigation rose until Governments in the Murray-Darling Basin introduced the Murray-Darling Basin Cap, due to the rapid ecological degradation and reductions in access to users. Diversions were capped at 93-94 levels of development[5]. Yet this mechanism did not adequately slow the continuing degradation or diversion of water, which still continues today. The development on floodplains and diversion of water into off-river storages further contributed to degradation of ecosystems[28].

Further expansion of dams or increasing their capacity will continue to have significant impacts on ecosystems, including rivers, wetlands, floodplains and estuaries. It will also affect communities reliant on ecosystem services delivered by rivers[17]. There is a critical need to avoid long term costs of such developments. The current focus on rehabilitation of the Murray-Darling Basin, a bipartisan commitment, is primarily due to overallocation of the water resource stored in dams. The investment in the buy-back of water and increased water efficiency is designed to return environmental flows to rivers and increase their resilience, which was exposed during the Millennium Drought.

The degradation within floodplains and freshwater ecosystems around the world can be directly attributable to the development of dams. This includes a loss of more than 50% of certain types of wetlands during the 20th century in Australian and other countries[18]. Further water diversions will ensure a continued decline in the health of river systems, including their ability to adapt to climate change[23]. Current abstraction of water has caused the fragmentation of waterways and floodplains and has both upstream and downstream effects [21]. In current scientific research into the rehabilitation of freshwater ecosystems, there are increasingly progressive options for restoring river health[15], but none include increasing dam capacity. Further, due to the ongoing costs of dams on ecosystems and communities, there is a call for more ongoing assessment of costs and benefits through period licencing which provides mechanism for regular review[24].

Additional to ecosystem health, river regulation also has a social and economic impact on floodplain communities and industries such as tourism and fisheries. Worldwide freshwater fish species are in decline, with more than 20% of the world's fish species being declared threatened or extinct in the last few decades alone[18]. Reductions of fish due to ecosystem degradation results in equal reduction in fisheries, for example, the fisheries in the Coorong, Lower Lakes and Murray Mouth worth $5.5 million/year were threatened when the area was in ecological decline[15]. Additionally, tourism within wetlands is a regional industry that relies on the continued health of these areas. For instance, from just a single wetland in the Murray-Darling Basin, the Barmah Forests, can yield up to $13 million through tourism uses in half a year[8]. River regulation damages these industries as it damages the ecosystem health. Expansion of dams for agriculture alone ignores the other values and industry supporting local communities.

Given this impact of building of dams and the water that they store, there is a need to improve Australia's efficiency of water use. As the world's second highest per capita user of water, there are opportunities to focus resources on reducing the demand for water resources through demand management mechanisms, also improving our efficiency of water use and capture of storm water in urban areas. If these could be implemented, it should not be necessary to introduce new dams or increase storage capacity of current storages.

b. Models for determining water requirements for the agricultural, urban, industrial and environmental sectors

Models for estimating water requirements must be comprehensive, reliable and flexible so that water managers can assess different management options and make informed decisions. Water requirements of urban and industrial sectors are based on an extensive urban and rural metering network. Unlike consumptive demand, far less is known about environmental water requirements.

Environmental water requirements are essential for maintaining function and health of aquatic ecosystems. Healthy aquatic ecosystems provide valuable services such as water filtration, recreation and fisheries, and are globally worth an estimated $15 trillion each year[19]. Environmental water requirements are inadequately represented in current water management. This has resulted in insufficient water availability, resulting in widespread decline of ecosystem health[3,6,13]. The first step in defining environmental requirements is to assess the composition and condition of species, using flora and fauna inventories, habitat mapping, and field studies. Water requirements then need to be defined for each ecosystem and its key processes. Currently there is poor investment in this area and so our understanding is limited. There are a few groups of organisms where this is more comprehensive, including waterbirds, river red gum, fish breeding and invertebrates. There are many scientific methods for determining environmental flow requirements applicable across multiple contexts with varying availability of ecological data[2,26,29]. They range from simple methods which preserve ecologically important characteristics of the natural flow regime, to more complex models which link flows to ecosystem responses. Once water requirements have been defined, they need to be integrated into current management.

Hydrological models currently used by the NSW Government can be used to assess potential integration of environmental flows into existing regulated (dams) river systems, and identify necessary policy or structural readjustment. Ongoing research and monitoring is critical to improve estimates of environmental water requirements and to monitor changing requirements. Remote sensing is suitable for gathering information systematically across space and time and monitoring the extent and dynamics of flooding and ecosystem response to flooding.

In addition to environmental water requirements, there are three areas which need to be better represented in demand models: floodplain harvesting, operational losses and plantations. Floodplain harvesting is the interception of overland flows in floodplains for private benefit. An estimated 400GL of water is harvested for use on properties by engineered structures [4]. This demand is not accounted for in current modelling. Remote sensing can be used to identify structures and quantify volumes intercepted. Operational losses result from storing and delivering water in on-river and off-river storages. They include evaporation, seepage and evapotranspiration. These highly variable and complex losses make up a considerable portion of the water balance, and should be quantified and incorporated into estimates of water requirements. Further, forestry plantations for the production of timber and pulp decrease runoff throughout a catchment; however their water requirements are not well modelled.

Determining future water requirements for water users is currently a linear process where current demand is translated into a forecast of expected water use. As populations and industries expand, the demand for water is likely to exceed finite water supplies. Demand management, by contrast, is an iterative process that involves establishing water conservation targets and implementing measures to achieve them. Demand management strategies used in NSW include prioritization, efficiency, cost-reflective pricing, education, water recycling and restrictions. To meet the future water needs, governments must assess the effectiveness of current and proposed demand management strategies. This requires models which are flexible and can be used to systematically examine management alternatives. Demand forecasting and demand management models must be scientifically robust to ensure they are suitable for management decisions. Scientifically robust models must be validated against independent, observed data to determine their accuracy. They should include a margin of error to account for the uncertainty, complexity, and non-stationarity of water availability and demand behaviour.

Models should be peer reviewed by anonymous reviewers to ensure they are credible. To ensure models are used appropriately, their development and validation should be well documented and assumptions should be clearly stated. Model outputs and associated information should be publicly and freely available to benefit multiple stakeholders, including water users. The internet is a suitable platform for data sharing and is currently used by the NSW Office of Water for sharing real-time river gauging information.

c. Storage management practices to optimize water supply to the agricultural, urban, industrial and environmental sectors.

Optimal water management systems make the best use of water available for multiple objectives, including agricultural, urban, industrial and environmental sectors. The potential for optimizing storage supply in each system can be assessed using mathematical optimization models. Optimization models are commonly used in hydrology to optimize water supply for multiple objectives within specified constraints[11,30]. To measure the potential to optimize water supply, model yield can be compared with yield under current water management, derived from Integrated Quantity and Quality Model in NSW. These can be used as a benchmark as new management practices are introduced and yields are reassessed.

Storages are rarely full and there are opportunities to better utilize the airspace. Currently, the volume of water that individual water users can store in a dam is restricted. This results in low dam volumes, because many irrigators needing to store large volumes of water have transferred their water to private off-river storages. These off-river storages are expensive to construct and are situated on floodplains where significant evaporation losses. An alternative water management option is to remove the restriction on individual volume in the dam, allowing users to accrue as much water as they require. This makes better use of existing storage space and reduces evaporation losses for irrigators. When the storage spills, water can be forfeited from each user in proportion to the amount they stored.

Storage evaporation is a major cause of water supply loss in regulated rivers which will increase with temperatures under climate change. Water efficiency measures are effective for reducing losses and increasing water supply in surface water systems. Bulk releases of water from the storage can help minimise losses downstream. Water releases should occur in months when evaporation is lowest. To minimise evaporation from the storage surface, groundwater storage may provide potential to store large volumes of water with reduced evaporation losses. Another option is to use storage covers, serving as water retention facilities and roofs for solar panels. Land use decisions in the upper catchment also have a significant impact on water availability[35]. For example, for every 1ML of farm dam development, streamflows are reduced by between 1ML to 1.3ML[20]. Storage management should therefore not be separated from land management.

There are also opportunities to optimize the value of water use and provide incentives for water efficiency and conservation. Water trading in agricultural river systems of NSW is an example of using economic markets to provide water to the highest value use. Water markets allow users to trade temporary (allocations) and permanent (entitlements) water access rights. Temporary trading allows for opportunistic water use. For example, extractive users can purchase extra water for planting crops when economic markets are strong, and environmental water users can purchase water to complete an ecologically important event such as waterbird breeding. Permanent trading has benefited irrigation communities who can sell water at premium prices, and also benefitted the environment who can enter into the water market by purchasing water from willing sellers.

There are also potential opportunities for aquifer recharge where evaporation rates are considerably less than from surface water storages.

d. Proposals for the construction and/or augmentation of water storages in NSW with regard to storage efficiency, engineering feasibility, safety, community support and cost benefit

There is widespread scientific evidence from Australia and around the world of the significant costs of building dams on downstream communities and ecosystems. Proposals for new storages need to be carefully considered and assessed to determine long-term costs and benefits. This not only applies to large dams; the cumulative effects of small dams is equally damaging[7]. Downstream ecosystems are primarily dependent on river flows that deliver nutrients and water resulting in high productivity of wetlands and riparian areas and estuaries. Floodplains are among the most threatened ecosystems globally, even though functioning floodplains are among the most valuable ecosystems for supporting biodiversity, and providing goods and services to society. Their scarcity and vulnerability is primarily as a result of the impacts of dams. These floodplains provide vital habitat for large numbers of birds, fishes and frogs, but also absorb large floods, improve water quality, provide good grazing for cattle industry, and fish breeding habitat.

The environmental costs of dams were once thought inconsequential. However the whole scale loss of fisheries, sediment transfer and floodplain inundation has serious consequences not only on the river, wetlands and land, but also financial cost to communities. The immediate effect to the surrounding area is the irrevocable change from a natural, shallow, moving water system to an artificial, deep, standing water reservoir. The surrounding land is lost to other uses, which may have had high value including loss of habitat for wildlife[31]. The creation of the storage lake can destroy fish spawning habitat, as well as breeding conditions for frogs and other animals. While there may be some gains from stocking of introduced fish species into the reservoir for recreational fishing, these species can escape and cause further damage to native species.

The dam itself also represents a barrier to fish migration and spawning. Mitigation measures such as fish passageways do not always fulfil their intended purpose. Specific knowledge of target species is required for effective design but which is lacking for most species[16]. Released water from the dam has a different composition to normal flow; it is colder and has reduced quality because it is released from the bottom on the dam. This also can stop fish breeding and affect survival of others. These effects can be felt for several hundred kilometres downstream[27].

The physical impact of the dam on downstream river functioning is also problematic and often difficult to assess until decades later. Silt, sediment and nutrients from upstream river flow or large floods are crucial for replenishing fertile soils. Dams prevent this happening, curtailing downstream agricultural productivity[17]. Therefore how the river contributes to the value of the land downstream and how this would change if the current regime is altered, need to be accounted for. Fish and local-scale fisheries may be affected along the entire river to the estuary and even out to sea. Many marine ecosystems rely on river flows[9]. All this depletes fish, frog and invertebrate populations, which has detrimental effects on the whole river ecosystem, but also impacts on downstream fisheries and agriculture-based livelihoods. Downstream of the dam, the replacement of the natural flow and flood patterns to a more stable, regulated flow severs the connection to floodplain wetlands. The cost of building new dams and losing these services is likely to be greater than short term benefits.

The purpose, capacities, life-span of new dams or increasing the size of old dams should be carefully calculated and assessed. This requires use of long term river flow data, climate data and evaporation rates to determine likely yield. If assessments are made of yield, it is critical that assessments are also made of the long-term impacts. For example, water resource development in the Murray-Darling Basin has significantly impacted on ecosystems [3,14]. Also, the South Australian and Australian Governments have spent more than two billion dollars dealing with the impacts of the last drought and water resource development upstream[15]. As well as assessment of yield and impacts, there needs to be assessment of climate change impacts to ensure that dams achieve proposed function. There may be more efficient ways of achieving the same results, including improved demand management (e.g. water-use efficiency by recycling water, improving seasonality of water demand by changing irrigation methods and mix of crops, and improving irrigation water-use efficiency)[32].

Sustainable flood mitigation can incorporate non-structural approaches, including wetland restoration, floodplain reconnection or compensated relocation of at-risk homes and businesses - options cheaper than building a new dam. Both the World Commission on Dams and the World Bank state the performance of existing infrastructure should be maximised in preference to construction of new dams because of the significant ecological and socioeconomic impacts[33,34]. Additionally, in Australia the environment is increasingly recognised as a legitimate user of water with environmental flow licences (http://www.environment.gov.au/ewater/index.html).

Dams severely disrupt environments onsite, upstream and downstream[25]. Many factors need to be assessed before considering new dams. Initial engineering costs need to include continual maintenance and upgrading for the life-time of the dam. This should include details on how fast the dam will accumulate sediment, reducing its storage capacity and amplifying flood risk[22]. Additional environmental mitigation measures can be costly to implement after construction, and may not achieve their purpose. Long term changes to the water channels downstream of the dam can cause erosion and may require stabilisation.

e. water storages and management practices in other Australian and international jurisdictions,

Over half of the large river systems around the world have been affected by dams and these dams have caused significant environmental damage[21]. These dams have led to large costs on behalf of the environment, society and taxpayers[33]. There is increasing understanding of the long-term ecological and socio-economic costs of storages. Governments around the world are beginning to consider the possibility of improving management of storages to reduce their ecological impacts.

The management of environmental flows, mostly stored in dams, will require considerable focus on effective management to deliver the best environmental and ecosystem service outcomes. Much of the environmental flows will be provided for landholders to improve the condition of rivers and also the amount of flooding from which many derive their income. There are other countries that are considering improving the licensing of dams through time-limited licensing which allows for routine assessment and improvement of dam operations[24]. This process could also be used to assess the relative improvement of the environment as a result of environmental flow management.

f. any other matter relating to the adequacy of water storage in NSW.

There is considerable focus on the 'supply-side' of the equation for providing water to industry, agriculture and urban communities. It is critically important to consider the 'demand-side' and reduce NSW's per capita water use. Australia is among the largest users of water on a per capita basis in the world. Given the country is also the driest inhabited continent, there is a clear need to use our water resources wisely and reduce dependency. This is particularly important, given increasing populations and provision of food security, given that much of our food is grown using irrigated water. Governments have increasingly provided resources to improve efficiencies of water access (e.g. Australian Government $5.8 billion for water infrastructure in the Murray-Darling Basin). Such improvements will be affected with new water storages or increasing the capacity of current water storages.

There are many other demand reductions strategies, some discussed above, that are relevant around the world, including improving efficiencies of water infrastructure in urban areas (i.e reduction of leakages) and increasing use of grey water. In urban areas, reduction in demand can also be achieved through a focus on local supply (rainwater tanks; urban runoff capture).

There are many innovative ways for improving efficient use of water without building new storages or increasing the capacity of water storages in NSW. New storages and increasing capacity of current storages will impact on agricultural lands or other public lands. This will have significant ecological impacts downstream that occur over decades or more and will affect communities reliant on the ecosystem services delivered by rivers.

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