Submission to The House Standing Committee on Agriculture and Water Resources by Professors R. Quentin Grafton and John Williams, Crawford School of Public Policy, the Australian National University, 21 March 2017.

Myths about Water Savings and Subsidies for Capital-Intensive Irrigation Technologies: Policy Implications for Australia

1. For the purpose of this submission we define water use efficiency as irrigation efficiency. Irrigation efficiency is the physical ratio of the amount of water beneficially consumed by growing crops to the volume of water either extracted from the water resource or the volume of water actually delivered to a farmer's field.

2. There are many myths related to irrigation efficiency. One of the greatest myths is that increased irrigation efficiency associated with more capital intensive irrigation methods <u>always</u> results in: (1) farmers either applying or consuming less water and (2) water 'savings' that flow back to the environment in the form of increased stream flows.

3. In our joint submission, we provide high-level guidance as to why these myths are unfounded, highlight the consequences of subsidies for capital-intensive technologies aimed at increasing irrigation efficiency, and provide advice as to what should be done to rectify past policy errors in providing subsidies for irrigation.

4. We first describe a stylised physical water balance in a river basin. Namely, over a given period of time and defined spatial scale, and restricting ourselves to only surface water for ease of exposition, the water balance is:

   Precipitation – Evaporation – Runoff (or stream flow) – Transpiration - Seepage to groundwater = Change in Surface and Soil Water Storage

   Evaporation is a water loss (an outflow) and is <u>non-beneficial consumptive water use</u> in the sense that as water in rivers or storages or in the soil becomes water vapour, it can no longer be directly used by rivers, plants or animals.

   Transpiration is also a water outflow, but unlike evaporation it is used directly by crops. Thus, transpiration that occurs to support crop growth in farmers' fields provides direct benefits and is considered a <u>beneficial consumptive water use.</u> In general, transpiration is linearly related to crop yield for a specific plant variety.

   Runoff or stream flow is another water outflow. This is a <u>non-consumptive water use</u> in the sense that water is not lost (in the short term) to the atmosphere as water vapour (or plant growth), but instead is relocated to another part of the basin system (for potential re-use). It is runoff that allows streams to flow. It is these stream flows that provide a range of key ecosystem services, such as fishing, forestry, tourism and benefits to wildlife.

   Stream flows provide the means to conveyance water downstream for multiple extractive water uses, such as for irrigation or for drinking water. Runoff is also essential for groundwater recharge, an important buffer for extreme climatic events,

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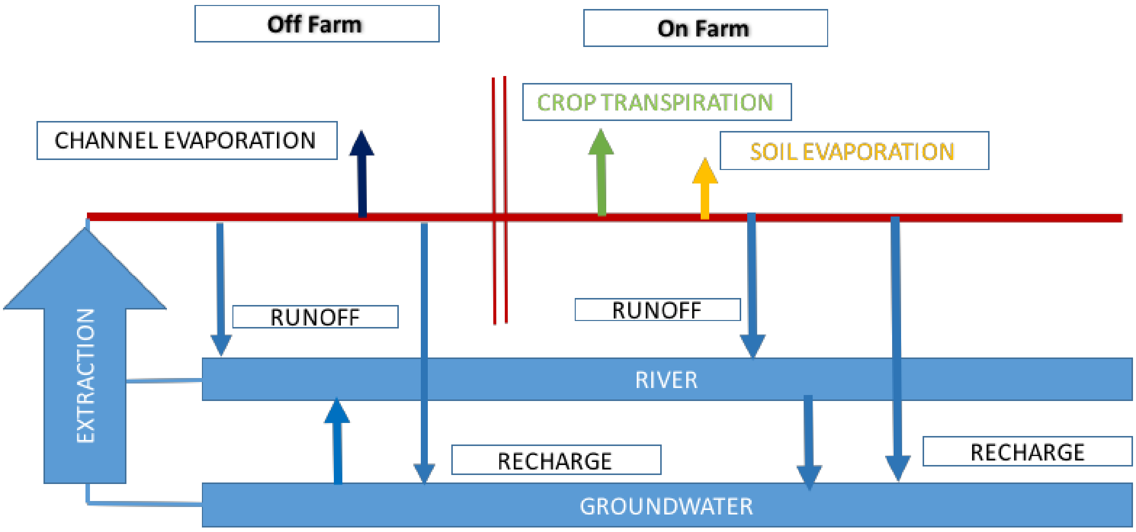
such as longer-term droughts, and allows water to be recovered and then used at a later date.

Seepage is deep drainage, and is another water outflow. Seepage provides recharge of groundwater systems, either on or off farm.

A simplified representation of the water balance is provided below:



5. Irrigation efficiency can be as low as 30% for water delivered to farmers' fields for certain types of irrigation, such as flood irrigation, and perhaps as high as 80%, or possibly more, with drip irrigation on laser-levelled fields. A key stated purpose and goal of increased irrigation efficiency is to 'save' the water that was previously 'lost' for non-beneficial consumptive use and, thereby, increase the amount of water available for other purposes such as stream flows or other consumptive use, such as industry.

6. The so-called 'saved' water from increased irrigation efficiency can only arise from either reduced soil evaporation, reduced runoff, reduced seepage to groundwater, reduced transpiration or a combination of all four water outflows. It is worth noting that these outflows are not necessarily independent because, for instance, concrete lining an irrigation channel may change seepage, evaporation and runoff.

7. Typically, increased transpiration increases plant biomass in a linear fashion as crop plant transpiration seeks to meet evaporative demand from the atmosphere. Once this atmospheric evaporative demand is satisfied further beneficial water consumption does not result in any further increase in biomass or yield for a specific variety; instead, increasing water application to plants beyond the point that evaporative demand is satisfied can result in yield declines, or even entire crop losses in the case of flooding. Thus, if crop yields rise as a result of increased irrigation efficiency for a given plant variety then this is a result of <u>increased</u> beneficial water consumption.

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8. Higher irrigation efficiency is, typically, associated with reduced runoff and seepage to groundwater, especially in stressed river basins. This is because water that previously was able to infiltrate soils and seep past crop root zone to replenish groundwater and base flow of stream flows after being applied to farmers' fields (such as through flood irrigation) is diminished with more capital-intensive methods of irrigation, such as drip irrigation. Only when there is a more than offsetting reduction in water application rates, and a corresponding reduction in water extractions, will stream flows or groundwater recharge be unaffected.

9. The consequences of reduced runoff and seepage to groundwater is that less water is available to be recovered and used downstream or later withdrawn from groundwater sources. This will, typically, reduce ecosystem services and impose costs on downstream users in stressed river basins and reduce the water available for downstream use and/or lower quality water.

10. It is worth noting that that it is the reuse of downstream flows that ensures, even if irrigation efficiency at a farm scale is low (such as 30% in the Nile River Basin), the overall Basin-level efficiency (ratio of water beneficially consumed to water applied at the basin scale) can be much higher (or about 80% in the Nile River Basin).

11. The combined effects of increased irrigation efficiency on the outflows of the water balance provides an explanation of the so-called 'Hydrological Paradox'. Namely, that increases in irrigation efficiency at a farm level can, and often does, result in reduced stream flow or runoff at the basin scale. This occurs because as irrigation efficiency increases, less water is, typically, available as runoff to rivers and streams or as seepage to groundwater to be recovered downstream or used at a later date as groundwater or stream flow.

12. The 'Jevons Paradox' helps explain why, as irrigation efficiency increases, there is a widespread (but not universal) tendency for an increase in local water consumption in many environments. This arises from the, more or less, linear relationship between transpiration and biomass or the yield for a given plant variety. If more capital-intensive irrigation methods result in increased beneficial water consumption so that crop yields increase because of prior sub-optimal (in a bio-physical sense) crop transpiration, then this means 'more drop, more crop' rather than what many believe is 'more crop per drop.'

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13. Contrary to expectations, more timely and frequent irrigation promoted by higher irrigation efficiency that increases crop transpiration (beneficial water consumption), and may have little effect on reduced soil evaporation. To the extent that higher irrigation efficiency expands cropped areas, and which has been reported in various locations around the world, and also shifts cropping patterns to more water-intensive crops and increases cropping intensity, this may also increase the water applied to farmers' fields.

14. The Jevons Paradox is a 'rebound' effect whereby an increase in irrigation efficiency, which increases the ratio of the volume of water beneficially consumed to the amount of water applied on farmers' fields, can result in increased water consumption. This rebound occurs because of a 'productivity' effect that means crop yields can be increased from the same amount of crop water applied (more drop, more crop).

15. A key contributor to the rebound effect in the water consumed by farmers, even with increased irrigation efficiency, is the widespread use of government subsidies to promote increased irrigation efficiency when such subsidies are directed to advanced or capital-intensive irrigation technologies, such as drip. This is because irrigation subsidies reduce the costs to farmers of improvements in irrigation efficiency that, in turn, augments the relative importance of the productivity effect (as costs borne by farmers are reduced because of subsidies) and, thus, increases the likelihood of a rebound effect in terms of overall water consumption by farmers.

16. It is an empirical question as to whether the increased cost associated with higher irrigation efficiency can more than offset the productivity effect and, thus, result in lower water consumption by farmers. There is empirical evidence to indicate that the productivity effect appears in many places of the world to more than offset the cost effect and, thus, results in <u>higher</u> local water consumption.

17. The justification of subsidies for one sector of the economy is that they provide public good benefits that more than outweigh their associated costs. These associated costs include the costs of imposing higher taxes on other sectors of the economy, and also the costs of not providing benefits to others in the economy who are not recipients of the subsidies.

18. The justification for irrigation subsidies are based on one or more of the following premises: (1) Irrigators are poor and/or vulnerable relative to others and, thus, a subsidy is a form of a transfer payment from the relatively well off in a society to those who are relatively less well off; (2) Irrigation subsidies increase domestic food production and, thereby, improve domestic food security especially for the poor and vulnerable; and (3) Subsidies that increase irrigation efficiency 'save' water, thereby, making more water available for agriculture or for other purposes such as increased stream flows or industry.

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19. In a rich country, such as Australia, irrigators have, on average, a higher average level of wealth than others in their communities (including neigbouring farmers who do not employ irrigation), and also relative to the national average. Thus, subsidies directed to irrigators that increase irrigation efficiency do not provide a benefit to the less well off in Australia. Indeed, to the extent that irrigators have a higher average wealth than the national average and many multiples the wealth of poor Australians, who have very little or zero net worth, it represents a 'regressive' rather than a 'progressive' transfer.

20. Australia is a net exporter of food and does not suffer from food insecurity at a national level. While there are some who may have an inadequate diet, especially in terms of micronutrients, these are almost exclusively some of the poorest Australians living in the most remote parts of the country, and do not include irrigators.

21. Given that subsidies to irrigators in Australia to increase irrigation efficiency are regressive transfer payments then the only public justification for them is that the intended water savings from these subsidies provide public good benefits. These public benefits are claimed to be in the form of: (1) community benefits where irrigators reside or (2) increased stream flows that increase ecosystem services.

22. If community benefit is a goal of irrigation subsidies, it is puzzling that the communities themselves where irrigators reside have not been allowed to determine how to spend the money rather than have it decided for them in the form payments to increase irrigation efficiency. It is further puzzling that if a key goal is to help poor and vulnerable in Australian irrigation communities that the most poor and vulnerable in such locations do not receive any direct payments or transfers. Indeed, the opposite is the case, as it is the wealthiest in these communities, the irrigators, who are the direct beneficiaries of the subsidies.

23. The claim that subsidies to increase irrigation efficiency 'save' water are not supported by the available evidence. Namely, average water application rates or water delivery per hectare in 2014-15 to farmers' fields in the MDB are almost the same as they were in 2002-03. Thus, if the average water application rates are, more or less, unchanged and if irrigation efficiency has increased with subsidies then we would expect this would also have reduced runoff or seepage. The key question from a taxpayer perspective, therefore, is whether subsidies (direct and indirect) to irrigators (on average per irrigator of about $200,000 over the past decade), have actually increased stream flows to justify the expenditures.

24. The claim that subsidies to increase irrigation efficiency have resulted in materially increased steam flows is not, as yet, supported by basin-scale evidence. For instance, dredging to keep the Murray mouth open recommenced in January 2017 due to low flows. Yet the Murray-Darling Basin (MDB) is not in drought and one of the goals of the 2012 Basin Plan was to ensure there would be no dredging in 95% of years.

25. The onus of proof lies with the recipients and administrators of public subsidies to justify that the funds spent have generated public good benefits and 'value for money'. Such evidence at a basin scale is currently not available despite expenditures in excess of $3 billion and planned expenditures of some $1.6 billion on the *Commonwealth On-Farm Further Irrigation Efficiency (COFFIE) Program*.

26. What evidence is available is unequivocal. Namely, the cost of acquiring water for the environment in the MDB from the use of subsidies is <u>at least twice</u> as much as purchasing water entitlements from willing sellers. In some cases, such as the Northern Victoria Irrigation Renewal Project, the cost of acquiring water for the environment with infrastructure subsidies was about five times as expensive as purchasing water entitlements. Despite these facts, Australian governments recently agreed to stop all purchases of water entitlements for the purpose of increasing environmental flows.

27. Evidence of lack of progress, to date, in terms of environmental benefits in the Basin is provided by the 2016 Australian State of the Environment (SOE) Report that was published in March 2017, and which includes a specific report on Inland Water. Its findings on the MDB are for the period since 2011 and it provides an assessment grade of <u>very poor and deteriorating</u> for the 'state and trends of inland water ecological processes and key species populations'. The SOE Report further observes that there is "widespread loss of ecosystem function" in the Basin. The SOE also notes that, in terms of the 'state and trends of inland water flows and levels' in the MDB there has been no Basin-wide improvement since 2011 and that "Longer-term downwards trends in flows seen in nearly 50% of stations, with no change in trends evident since 2011."

28. The overwhelming evidence from Australia and many other places in the world is that providing subsidies to increase irrigation efficiency does not, by itself, result in water 'savings' at a basin scale (see figure above). Indeed, if maintaining stream flow is an important goal then such subsidies, by themselves, can result in unintended consequences and actually reduce stream flows and groundwater recharge.

29. The lack of cost effectiveness and the likely absence of public good benefits associated with the proposed billions of dollars of subsidies to increase irrigation efficiency in the MDB were predicted within weeks of the announcement of the $10 billion *National Plan for Water Security* announced in January 2007. Yet multi-billion subsidies for irrigation have continued to be paid, and billions more are promised.

30. In sum, the best available evidence tells us that spending billions on subsidies to increase irrigation efficiency cannot be justified from the perspectives of: (1) the public good; (2) cost effectiveness; or (3) value for money. Australian taxpayers, as do poor and vulnerable Australians who could have benefited from multi-billion transfers that have been directed towards irrigation, deserve much better. Based on the best available evidence, the only possible decision in the national interest, and especially in times of on-going budget deficits, is that all public subsidies to increase irrigation efficiency be immediately suspended.

31. Instead of providing subsidies to increase irrigation efficiency through more capital-intensive technologies, there should be a transparent and deliberative process that includes all relevant Basin communities, stakeholders and interested parties to spend the funds that would otherwise have been allocated for irrigation subsidies. This process should maximise participation to the poor and vulnerable within the MDB and explicitly consider the key bio-physical and socio-economic risks to Basin communities.

32. Given the frequency and the huge and negative impacts of prolonged droughts to the rivers and communities in the MDB, explicit consideration must be given to supporting bio-physical and socio-economic resilience within the Basin. Increased resilience would support Basin communities and also the environment to rebound and to recover faster following the negative shocks of prolonged droughts and the possible negative consequences of climate change.

33. Various participatory processes could be used to ensure a transparent method of decision making that would deliver much better public good outcomes for the billions of dollars yet to be spent on ‘Restoring the Balance’ in the MDB. A Risks and Options Assessment for Decision-making (ROAD) process that has been developed and successfully applied in Vietnam and South Asia is one such process with which we are most familiar.

34. In closing, we recommend to the House Standing Committee that the Australian government: (1) Immediately suspend any further expenditures on irrigation subsidies in the MDB; (2) Undertake a detailed audit of the effects of irrigation subsidies on stream flows and groundwater recharge, and the cost effectiveness and ‘value for money’ of such subsidies, in the MDB; and (3) Implement an adequately funded and transparent process to ensure ‘value for money’ for Australian taxpayers and to deliver better outcomes for Basin communities and its environment, especially during periods of prolonged droughts.