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Incorporating on-farm water storage safety into catchment policy frameworks: International best practice policy for private dam safety accountability and assurance

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ABSTRACT

The safety of catchment basins is threatened because of the potential and severe consequences of private on-farm dam failure. Such failure follows inadequate development and implementation of accountability and assurance policy in relation to water storage, a consideration which resources and land use policy planning must take into account if lives, private property, public infrastructure and the environment downstream are to be saved. Thus, this paper aims to explore the interrelated policy issues associated with improving safety of farm dam water storage structures to mitigate individual and cumulative dam failure threats. The paper provides insights into the design of best-practice resources and land use policy for the Australian setting based on contemporary international best practice in private dam safety accountability and assurance policy. A strategic literature review identifies international dam safety policy benchmarks from minimum to best practice. Practical application of the benchmarked policy is then undertaken through case studies in two contrasting Australian states, Tasmania and South Australia, which literature suggests represent a leader and laggard in terms of best international policy practice. Whilst Tasmania provides leadership and best practice in comparison with international policy benchmarks, the paper reports data from a 15-year longitudinal case study which confirms that South Australia lags and demonstrably would benefit from application of the policy guidelines developed. The case study on appropriate dam safety management accountability and assurance policy development for catchments in two strongly contrasting state jurisdictions in Australia is novel, as are the recommendations developed for how resources and land use policy can best address cumulative threats from smaller dams in catchments. The case study and recommendations can assist similar jurisdictions world-wide to address the threats associated with farm dams in catchments.

Introduction

On-farm dams are indispensable to most agricultural businesses as they provide water supply for irrigation and farming activities (Lewis, 2002; Smith, 2001). When evaluating catchment-wide resources and land use policy, previously identified best-practice policy responses for safe on-farm water storage management are available and can be used (Pisaniello, 1997, 2010, 2011; Pisaniello and McKay, 1998, 2007; Pisaniello and Burritt, 2010). However, research is needed into the design of best-practice resources and land use policy for the Australian context as it applies to safe farm dams in catchments. There are at least 735,000 farm dams in Australia (Baillie, 2008), thousands of which have failed and many more posing significant safety threats (see Pisaniello and McKay, 2007; Lave and Balvanyos, 2006). Failures of large dams are spectacular and receive much more attention than those of smaller dams. However, small dam failures, particularly those of privately owned farm dams, occur far more frequently (Lewis and Harrison, 2002; Pisaniello, 1997; Pisaniello and McKay, 2007). Small dam failures internationally have had disastrous consequences (Silveira, 2008). For example, in the United States in 2006, the 13 m Kaloko farm dam in Hawaii overtopped because of blocked spillways and killed seven people in addition to causing widespread environmental damage (HIDLNR, 2010); and in 2009, the relatively small 10 m high Situ Gintung earthen dam in Indonesia failed by overtopping leading to the deaths of approximately 100 people and widespread damage to infrastructure in Jakarta (The Associated Press, 2009). On a cumulative scale the results of poorly managed dams can be catastrophic (Pisaniello, 2009). Throughout a catchment if a series of farm dams are managed inadequately then they can

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fail in a cascade manner where volumes of water from one dam unexpectedly are released into another leading to multiple failures and disaster. For example, in China in 1972, the Shimantan and Banquia dams failed because of the failure of 60 upstream farm dams, resulting in 230,000 deaths (Yi and Dai, 1998); in 1989 in the United States, the Evans and Lockwood dams, holding only 89 ML and 39 ML of water respectively, both collapsed in a cascade manner, killing two people (Graham, 1999); in 2010, a cumulative series of private dam bursts in Brazil left 50 people dead and an estimated 150,000 homeless, with a further 200 dams reported to be at high risk of cumulative failure (Pottinger, 2010); and recently, in February 2012, the cumulative failure of farm dams in Bulgaria resulted in the collapse of a water reservoir downstream with reports of at least 10 deaths (Novinite, 2012a,b).

Such reports of catchment-wide devastation from around the world demonstrate that without appropriate design, construction, maintenance and surveillance, poorly managed small dams pose both significant individual and cumulative threats, and can cause considerable losses to the communities and environments downstream (see also Pisaniello, 2009). Hence, this paper provides insights into the design of best-practice resources and land use policy for the Australian setting by identifying contemporary international best practice in private dam safety accountability and assurance policy and application to case studies in two contrasting Australian states: Tasmania and South Australia.

The research asks the question: how can best practice assurance benchmarks for private farm dam safety be integrated into water resources and land use policy for Australian catchments? The paper proceeds as follows: in the following section the benchmarked policy responses for safe on-farm water storage are established through a review of international policy benchmarks and standards for achieving 'Adequate' private dam safety ("International policy benchmarks and standards for private dam safety management" section). These standards and guidelines are then applied to the accountability and assurance policies for on-farm dams in two Australian states – Tasmania ("Benchmarked best practice approach from Tasmania" section) and South Australia ("Farm dam safety in South Australia" section) backed up by data from a 15-year demonstrative case study. Application of the benchmarked policy standards and guidelines facilitates discussion of the best-practice Tasmanian policy in contrast to poor practice in South Australia ("Discussion and application of the benchmarked policy guidelines" section). The paper concludes in "Conclusions" section with a summary of findings and highlights the importance of incorporating best practice dam safety policy into catchment resources and land use planning decisions.

International policy benchmarks and standards for private dam safety management

Within catchment resources and land use policy development is the consideration of the effects of farm dams and their individual and cumulative threat to safety of catchments if not adequately managed. For governments designing or implementing dam safety policy, the baseline in most countries, including Australia, is the Common Law owner responsibility that exists to manage dams according to current standards (McKay and Pisaniello, 1995; Pisaniello and McKay, 2007). In Australia, these standards are set by the Australian National Committee on Large Dams (ANCOLD; see ANCOLD, 2000a,b, 2003). However, many jurisdictions in Australia and overseas have found that it is not enough to rely solely on Common Law responsibility and benchmarks must be set to protect downstream communities, property and the environment from poor dam safety management practices (Li et al., 2008; Pisaniello and McKay, 2007; Pisaniello, 2009, 2011). For dam safety, a number of management mechanisms in addition to Common Law and statutory command and control are available to measure against benchmarks to ensure dam safety. However determining the most appropriate combination of safety management assurance mechanisms to meet policy benchmarks for catchments in different jurisdictions with different circumstances presents a number of issues. These issues are illustrated in the Australian context in the following sections. The available dam safety assurance mechanisms are discussed based on international review.

There have been comprehensive reviews of safety mechanisms of the farm dam management environments in the USA, Canada, United Kingdom, Finland, Portugal and South Africa (Pisaniello, 1997, 2011; Pisaniello and McKay, 1998, 2007). Results of the reviews find that farm dam safety mechanisms vary between and within countries although key components in certain practices can be identified, including Common Law, legislation, command and control regulation, administration, registration and classification of dams, surveillance, accounting and reporting, codes and/or standards of conduct, community education and preparedness, punitive enforcement, and owner education and guidance (Pisaniello, 1997; Pisaniello and McKay, 1998, 2007). Pisaniello (2011) finds that internationally, where there is significant regulatory pressure for safe farm dam management, mechanisms of best practice are emerging where the proper safety management of farm dams, both at the individual and cumulative levels within catchments, exists to provide assurance to communities and businesses downstream.

Pisaniello (1997, 2010, 2011) analyses the main characteristics of each of the above selected international practices (see also Pisaniello and McKay, 1998, 2007) to identify elemental benchmarks of "better" practice, and in turn develops detailed policy models of "best", "average" and "minimum" practice in line with the model benchmarks highlighted in Table 1 . In addition, for a government to determine the extent of private dam safety assurance policy necessary for its particular jurisdiction (that is, which of the three models presented in Table 1 to adopt), an indication or guide of the scope of the local dam safety problem is required. Pisaniello (1997, 2010, 2011) identifies two main guides that have been used by international practices for this purpose:

Level 1 Guide – density of potentially hazardous reservoirs
Level 2 Guide – density of deficient potentially hazardous reservoirs

The first level guide is the simplest to use, requiring the least effort and resources. Dams merely have to be identified from aerial photography, assessed for potential downstream consequences in the event of failure, and then assigned a subjective hazard rating. The second level guide requires much more effort and resources as a safety evaluation of each dam must be conducted, but it provides more accurate indication of the problem at hand. However, because of significant advances made in the fields of meteorology and flood hydrology, updated design floods are commonly found to be considerably greater than the floods which could cause failure of existing dams. As a result, nearly all existing dams when reviewed will have insufficient spillway capacities (Pisaniello, 1997, 2009; Pisaniello and McKay, 2007) which is also evidenced by the South Australian case study below ("Farm dam safety in South Australia" section). Therefore, most governments would be content to make a decision based solely on the magnitude of the first guide. At most, for additional reassurance that a problem does exist, a government may opt to initiate a small safety evaluation program based on only a sample of, for example, 10–20 private dams.

In order to establish limiting guide criteria (i.e. limiting values which would necessitate differing levels of policy), a set of leading international practices were analysed implicitly by Pisaniello (1997) with regard to: (i) the extent of the private dam safety problem in the area based on Level 1 Guide and if available, also