ASSESSING RISK WITHIN A TRIPLE BOTTOM LINE FRAMEWORK

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INTRODUCTION

Risk is defined in the Standard, Risk Management, AS/NZS 4360:1999 (Standards Australia and Standards New Zealand, 1999) as the chance of something happening that will impact upon objectives, and is measured in terms of consequences and likelihood. It may also be considered as the exposure to the chance of injury or loss due to a hazardous or a dangerous chance of either an occurrence or a non-occurrence. Mathematically, risk is based on the probability of an event or an outcome occurring; the greater the probability the 'higher' the risk; risk assessment is often, and unnecessarily so, unilateral in application. However, the Standard suggests that risk management is as much about identifying opportunities as avoiding or mitigating losses.

These theoretical concepts can be placed into an historical setting for more than half a century from the capital works undertaken during the 'Great Depression' which included roads, buildings and water storage dams. These works were unquestionably acceptable by society as employment relief schemes to reinvigorate the national economy as well as to minimise risks associated with inadequate infrastructure underpinning a developing economy. The last of the great infrastructure employment schemes was the Snowy Mountains Hydroelectric Scheme [SMHS] that lasted for almost a quarter of a century from the late 1940s to the mid 1960s which was approved by Federal Government under the Defence Act.

Two major forms of risk averting were advocated for creating the SMHS – to limit the risk of drought in agricultural areas and to minimise the risks from power failures. That is to say, the criteria for advocating the SMHS were based on the probability of economic outcomes if the project did not proceed, while assigning little or no value to the environment and societal risks even though the SMHS was also predicated on a perceived social criterion, ie, an expanding population resulting from the post war immigration program. Some would argue that this risk assessment process is the converse of contemporary assessment criteria, where the environmental valuation would outweigh any of the social or economic factors – that is, *ceteris paribus*, the SMHS would not have been built.

From the above overview two important events are identified – one, that for nearly half a century Australia has relied on additions and modification to existing capital works to accommodate Australia's highest period of population growth; and second, that there is a major shift in social attitudes and values which in turn are being reflected in legislation and policy making. The implications of these events have important implications:

- in a majority of cases, existing infrastructure has been expanded to accept ever increasing workloads rather than seeking alternative methods and/or locations; and
- use of existing areas is considered more socially acceptable than the use of additional land resources.

This quasi-engineering *cum* electoral - political problem solving technique has not addressed the long term risks of how these outcomes should be considered in terms of a balance between economic, social and environmental values. There is no transparency that a risk management process has been set in place to identify the risks or the sensitivity of the risk assessment process to changes of the

assumptions. To illustrate, many wastewater systems and reticulation schemes were constructed on the premise that they were socially, politically and economically justified by the economies of scale of major plants and the avoidance of using new sites. However, the discharge from these processing plants has mostly been to the ocean, river systems or agricultural reuse operations. These outfalls have been also justified on the basis of public health risks. What is now being questioned is how these risk assessments were undertaken and whether they had been subjected to comparative or sensitivity analysis.

DOING -*V*- NOT-DOING

Standard application of risk-based approaches is unilateral and non-comparative; that is, risk-based approaches tend to quantify a predetermined set of relationships between causes and effects. The hierarchy established in AS/NZS 4360:1999 is about chance (probability) and clear processes for identifying, monitoring and communicating at each stage in an iterative process. Within modern society two general notions appear to be emerging, the first is that risk assessment is 'mathematically correct' and the other justifying the 'not-doing' based on the inherent complexity and variability within natural systems – the 'Precautionary Principle'. From each of these notions incorrect conclusions can be drawn. To draw on a much publicised parallel example, risk reduction burning was ceased (or activities minimised) in some eastern states on the grounds of the precautionary principle – the impact of the 'cold' burns was not known. After the disastrous 2002 fires in New South Wales and Victoria there is now revised thinking that the risk to life and property (including natural bushland) from a single hot fire can be greater than accumulated impacts of cold fires. Similarly, governments regulating to maximise the treatment of domestic greywater before reuse or recycling has not only resulted in the significant loss of a resource to ocean outfall [or similar] but has also produced generations of suspicious populations. The question remains; is the risk to public and environmental ill-health from the reuse of appropriately treated sewage as high as the regulators would gauge? If so, where is the assessment in line with the accepted Standard?

In the period 2000-2004 there has been an apparent irrational behaviour by some urban water users (householders) who are prepared to 'risk' a fine, deleterious impacts on personal and public health, and to incur financial losses to re-use poorly treated greywater to allay the risk of losing the aesthetics of the home-landscape. Brennan and Patterson (2004) showed that domestic greywater recycling under current regulations in most states has a payback period in excess of 25 years if only valued against the water not used. In economic terms these consumers were paying more for an inferior good (recycled water) relative to the amount currently being paid for a superior good (potable water) … the difference being that the original good could not be used on the valued landscape. Consumer behaviour, in this instance, illustrated that the risks associated with a non-action (loss of amenity) were considered greater than those associated with taking an action (risk to public and environmental health). Since politicians have been advocating certain greywater recycling practices, the risk assessment processes seem to have avoided the need for rational risk evaluation criteria. The actions of the householders can be translated into a TBL framework using both government and householder perspectives [Table 1]

Table 1: TBL Comparison of using greywater in times of drought.

Issues	Government Account	Householder Account
Social	Health risks associated with the reuse of greywater; or Risk of using greywater less than the risks of running short of water.	Householders maintained a level of status having a flourishing garden when those about them were witnessing the impact of the drought and associated water restrictions.
Environmental	Could be asserted that the pre-treatment of the greywater was inadequate and this could have deleterious impacts on the natural environment.	The maintenance of the garden replaced the alternative of removing the drought affected plants and disposing at the local landfill. Maintained an environment for the household that was highly valued.
Economic	Cost of enforcing the restrictions on the use of greywater. Loss of water in treatment plants could result in need to alter procedures.	High cost of retrieving and applying the greywater to the landscape; Risk of high fines for illegally re-allocating the water in a non-rural area.

The perspectives in each instance are important. Risk-based analysis incorporates uncertainties associated with our knowledge of relationships – what it presumes, and perhaps incorrectly, is that government has superior knowledge. Or alternatively it may be that government readily accepts a risk aversion approach. While TBL outputs can be evaluated, it is contentious whether these are adequate for quantitative predictive models on which to make informed management decisions. Government and householders have reached different perceptions of risk, and therefore for government to assert that risk-based management has the advantage '… that the process encourages stakeholder involvement, is rigorous and scientific …' cannot be sustained in this instance [Pollino and Hart, 2003:30]. In the latest water restrictions in NSW for example, the only assessment that has been communicated with the public is that the water levels in the Sydney metropolitan water reservoirs has reached 55%. The risks from further drawdowns have not been clearly enunciated.

TBL APPLICATION

In June 2003 the Federal government published its guideline for reporting TBL reporting against environmental indicators, this being one of the few documents of its type on the subject (Environment Australia, 2003). While the state and territory governments are adopting TBL principles as official policy, there is no apparent commonality of reporting either between departments, within a jurisdiction nor between Australian jurisdictions. Unquestionably there are private sector firms that have benefited from adopting TBL principles [eg Cotton Seed Distributors, NSW] [Brennan and Patterson, 1993). In this project a risk-based assessment was adopted for both human and natural resources management. The terms of reference included decontaminating a highly polluted site as well as establishing guidelines to assist managers to undertake future risk-based monitoring. These processes are similar to those espoused in AS/NZS 4360:1999. Over a period of three years the production methods of this operation were taken from one of depositing highly polluted [chemical laden] water into a 'cess pit', to establishing a water reuse cycle that was safe for human recreational activities. A major aspect of this project was the identification of threats (risks) to catchment biota and the development of qualitative production models that focused on the scientific and technical aspects of the plant's operations (minimising risk of systems failure). The project also addressed the need for increasing the capacity for natural resources management, including water recycling, vegetation enhancement

and elimination of employee health risks [Brennan and Patterson, 1993]; a similar approach has been advocated by Pollino and Hart [2003:30] a decade later.

However, the converse is also true with Exxon-Mobil's price-earnings ratio exceeding both BP and Royal Dutch Shell by 30%, suggesting that investors believe the earning prospects for Exxon-Mobil are much better than for their greener competitors [Hayward, undated].

The NSW Department of Land and Water Conservation (now Department of Infrastructure, Planning and Natural Resources) prepared a review that addressed TBL reporting for water supply and sewerage performance (DLWC, 2003). As mentioned above, at federal [Hill, 2000] state and territory government levels, TBL is being adopted as a reporting mechanism for a selected number of activities, but is not applied across the whole range of environmental regulation. To illustrate, the NSW Land and Environment Court declined to hear economic argument [McNamara -v- Parry Shire Council and Rafalo, Land and Environment Court, 1988.]. Learned counsel argued that these limitations of fact before the Court were contrary to the spirit of the NSW Environmental Planning and Assessment Act, 1979 which requires the consideration of the social, economic and environmental factors – i.e., TBL assessment.

Further, the element of risk-based assessment is a notable absence from the majority of TBL reports prepared by state governments. By implication, risk based assessment is substituted by government regulation which Roodman [2000] concluded is destined to fail '… for precisely the reason that central planning has run aground almost everywhere it has been tried.' It can be argued that the inconsistency in risk-based assessment between Australian states, summarised in Table 2, highlights the weaknesses of the regulatory approach.

Table 2: Variation of State Regulation of Greywater: Australia 2003

State	Method	Regulation
NSW	Diversion*	Diversion of greywater from the bath, shower or laundry without storage or treatment generally does not need approval; however, Hastings Council (NSW) permits the use of greywater from washing machines only during periods of water restrictions.
	Storage**	Permitted with treatment via a domestic greywater treatment system (DGTS) that provides collection, storage, treatment and disinfection. Approval by local authorities.
Victoria	Diversion	Method does not need council's 'septic tank permit' but approval is needed to alter the sewer connection; may only be used for subsurface irrigation.
	Storage	Permitted with treatment via a domestic greywater treatment system (DGTS) which provides collection, storage, treatment and disinfection. Output may be used for surface or subsurface irrigation. Environment Protection Authority is approving authority.
Queensland	Sewered area	Greywater reuse is prohibited; must discharge to sewer (DNRM, 2003).
	Unsewered areas	Greywater is considered sewage and comes under the Onsite Sewerage Code; only when treated to secondary standard can it be reused.
South Australia	Primary treated	Greywater must be disposed of subsurface, while surface discharge requires treatment and disinfection. Greywater systems are considered alternative on-site wastewater systems and require approval before installation.
Western Australia	Bucketing	Permitted without regulation.
	Primary	Must be distributed in below ground trenches.
	Secondary treated	Application by microdrip or spray irrigation; requires approval from WA Health before installation (20/30/10 for BOD5, TSS and FC)

* greywater diversion devices [GDD] either by gravity flow or through a pump diversion (that is not a storage tank)
** Performance guidelines are set for the DGTS for BOD, TSS and FC.
Source: Brennan and Patterson, 2004

There are two main state policy classifications contained in Table 2: total prohibition of greywater reuse and restricted greywater reuse. Representing common convention that TBL is concerned with the assessment of values associated with proposed or existing developments, where these values form the trimorphism of economic, social and environmental composites, these values can be expressed as:

$$TBL = f\,(Values_{held,\ assigned}) \ldots. [1]$$

Where $Values_{held,\ assigned}$ is a trimorphic relationship that can be depicted as a matrix taking the form:

$$Values_{held,\ assigned} = \begin{bmatrix} \textbf{Values} & \textbf{Held} & \textbf{Assigned} \\ \text{Economic} & Eco_{Vh} & Eco_{Va} \\ \text{Social} & Soc_{Vh} & Soc_{Va} \\ \text{Environmental} & Env_{Vh} & Env_{Va} \end{bmatrix}$$

In those instances were policy prohibits the use of greywater, this can be represented as 'discounting' all TBL development values to a level approaching or equal to zero. Using function [1] prohibition states that the risk values have greater weighting than all other factors as represented in function [2].

$$TBL = f\,(Values_{\ held,\ assigned})^{\ RegRisk} \ldots. [2]$$

Where:

RegRisk is the regulators assessment of risk and this approaches the value zero as the perception of deleterious risk increases.
(Held and Assigned Values - nomenclature after Brown, 1984.)

Prima facie greywater prohibition appears to discount other forms of public risk; in terms of probability it is more likely that a citizen using the wastewater system would be killed in a car accident than by a failure of the on-site system, yet motor vehicles do not incur the same level of risk-based management. This paper is not disputing the need for objective risk assessment, in fact it proposes that risk assessment should be incorporated in any value calculating instrument, including TBL; however, it does challenge the application of risk assessment without scientific basis – that is a basis that can be measured, the measurements replicated and a sensitivity analysis included.

Function [3] advances that risk should be incorporated into the TBL framework in a manner that other factors are weighted in accordance with community standards of risk acceptance, rather than an *ad hoc* application of risk assessment within assessment frameworks such as is apparent in Table 2. The whole issue of speed restrictions is one based upon risk, however, that risk is often weighted by other imperatives, such as traffic flow.

$$TBL = f\,(Values_{\ held,\ assigned,}\ Risk_{\ acceptable}) \ldots. [3]$$

Where:

Acceptable risk is based on comparative community values of 'acceptable' risk, ie the probability of being killed in a road accident, incurring food poisoning, etc.
(Held and Assigned Values based nomenclature of Brown, 1988).

The difference between functions [2] and [3] is that in function [2] a mono-form of risk has discounted all other factors, while in function [3] environmental, social and economic risks are factors of the assessment procedure – that is the probability of an event occurring and the impact of that outcome is discounted by the probability of beneficial returns. This approach is consistent with business practice where managers assess risk of investment [often expressed in terms of financial risk including interest rates] or social risk [often expressed in terms of public liability or worker's compensation for example] – that is, there is a risk of some event 'occurring' or 'not occurring'. Not only does AS/NZS 4360:1999 discuss risk avoidance and risk aversion, it also considers risk transfer as well as retaining the risk (Standards Australia and Standards New Zealand, 1999). However, there appears to be an overemphasis within the environmental sector that all risk must be reduced, e.g. '…There is growing recognition that business has a crucial role to play in helping Australia to become more sustainable. As a result many Australian organisations are responding by reducing their environmental impacts and risks …' [Kemp, 2003]. For TBL to achieve its role in providing balance, the social and economic factors must also be considered in a balanced manner, including any associated risk factors. To this end both financial and, increasingly, social auditing plays an important role [TBL Website, 2004].

DISCUSSION

The burgeoning development of TBL is not without its own inherent risk; TBL assessment is replacing the traditional economics based Environmental Evaluation Systems and in doing so confronts a distinct possibility that assessments will become classified as 'Black or Red' [using the nomenclature of accounting practice], rather than adopting the more appropriate dynamic method offered by economics, such as benefit/cost analysis, as noted from the following statement by OptusNet:

> *It's become the latest series of buzz words to describe business involvement in sustainability. TBL is all about dropping the financial bottom line as a meaningful indicator of where you stand in the market place and replacing it with a bottom line that properly acknowledges the interplay of the social economic and environmental dimensions of our lives. The failure of Gross Domestic Product or GDP to accurately inform society about quality of life has now become mainstream. OptusNet, 2004*

The rigid 'profit and loss' syndrome is too inflexible and lends itself to corporate and political manipulation rather than community participation. Risk-based approaches in natural resources management have the potential to assist land-users in incorporating ecological criteria in decision-making, based upon assessment of each of the generic sources of risk. More importantly, risk-based assessments should facilitate the development of techniques and equipment for achieving sustainability of rural and urban water resources at a reduced risk (not a nil-risk). In order to protect remaining riverine environments the selling of water based on infrastructural costs to a population whose per capita consumption is effectively discounting the environmental factors as illustrated in function [1] above, i.e., where other considerations are overriding; the adoption of function [2] could result in the moving of population to areas were appropriate water supplies are available and recycling is the norm, not the exception. This is a prospect confronting each of the States' and Territories' capital cities, other major urban centres and major port areas.

Australian governments and their respective communities are facing a conundrum. There are those occasions were community values are determined by the

limitations imposed by the restricted capacity of aging infrastructure to meet population expansion and the demands for increased quality standards for the supply and disposal of water. Sydney water supplies are already at 106% of safe yield (EPA, 2003) Community demands are tempered by environmental and, conservation concerns offset by an increasing individual demand for water without price increases. It is the government agencies that must stratify a balance between these conflicting values within the expansion of urban centres and increasing demand generically. Selecting a risk-averse policy is unlikely to achieve beneficial outcomes because it is usually based around "doing nothing" rather than "doing something". Succinctly, an increasing population is demanding higher production quality standards for water while simultaneously demanding that water supplies be fixed by government with environmental constraints being the *raison d'être*. Paradoxically, in contradistinction there is also community resistance to price increases while at the same time consuming more. Resulting from these changes in community values water is now recognised as a scarce natural resource that is required by the natural environment as well as urban societies; this recognition of scarcity means that water can no longer be considered a free good, with the only cost being the harvesting and delivery.

Modern society is confronted not only with the cost of receiving water, but also its disposal. Traditionalist thinking within government is that all wastewater disposal should be centralised and controlled by government agencies. There is evidence that government is currently using technological methods to justify additional restrictions in relation to water reuse rather than encouraging technology to advance its social acceptance and environmental benefit. In a recent NSW Land & Environment Court hearing, a proposal for on-site treatment of wastewater from 22 residential units was judged against municipal water recycling guidelines on the basis that the risk of failure of the treatment system or subsurface irrigation system was too high, even though the water was tertiary treated water with additional ultraviolet disinfection.

The continuing trend for government agencies to dictate to those living with on-site domestic wastewater treatment, though risk averse regulations, do so in the belief that public and environmental health are of the highest priority, irrespective of any valid risk assessment.

Societal perceptions are however challenging this position, not on the criteria of cost, but on quality of life, which, in some instances, includes receiving additional benefits from water re-use Figure 1.

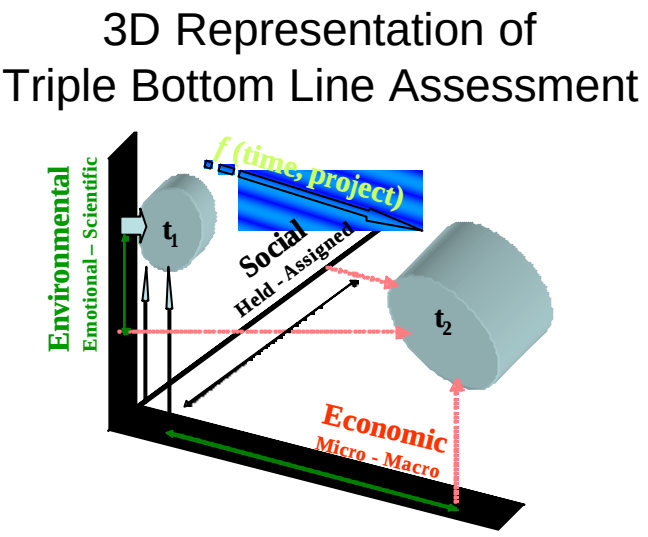

Figure 1: TBL represented as a composite trimorphism illustrating changing values, including environmental ideals [After Brennan and Patterson, 2004].

It is predicted that as governments pursue their reductionist philosophy the community will broaden its education and understanding of the environment with the consequence that there will be increased levels of conflict or, as already witnessed during the recent drought, civil disobedience. In the eyes of these committing the offences it was justifiable [t_2 in Figure 1] while the authorities

considered the matter with a degree of seriousness [t_1 in Figure 1]. Hayden [1996] draws attention to widening gaps between government regulation [including t_2 in Figure 1] the control of education and its environmental content] and a more informed community. From Figure 1 it can be deduced that:

f (interaction, consideration, politicisation, equity) equality …… [4]

From reviewing government response to greywater reuse the following conclusions are evident:

First, the regulators consider the community less responsible than government in its ability to supervise or maintain sewage plants [t_1 in Figure 1].

Second, greywater reuse either on-site or as a decentralised system, denies the community the opportunity of enforcing an open space in urban areas – a landscaped strategy with multiple domestic developments as well as commercial developments [t_2 in Figure 1].. This conclusion is reached on the logic that on-site package treatment plants require a minimum area of landscaping for the effective reuse of the effluent. This guarantees that landscaped areas must be maintained to a high standard, thereby resolving a perennial problem for local government authorities that insist on landscaping of developments, but which are unable to enforce on-going maintenance. It also negates changes in the price or availability of potable water.

Third, there appears little or no cognisance of social implications regarding the degree of risk compared to the total social benefits. Risk assessment should not be based on the ease of regulation enforcement, but on actual comparative risk i.e. assessing the probability of the number of persons at risk, and the consequences of the risk ranked from slight unwell disposition for 24 hours or death and the frequency of occurrence [one in ten years or daily].

That water has been used to transport human faeces and urine is not, in itself, a reason for the risk to be insurmountable. The risks can be easily averted by effective and efficient treatment and barriers between humans and the treated wastes. Thus, managed risk is achievable. While outside the scope of this paper, an approach to develop TBL generally, and the use of pre-used water specifically, is the reliance on modern technology enabling water quality to be used as an environmental currency. This approach not only encapsulates risk but also encourages the advancement of sustainability principles in regard to water use [Brennan, *et al.*, 2003]

CONCLUSION

This paper has highlighted the need for the application of a holistic and dynamic application of TBL, including the potential positive and negative impacts of risk and how the resulting application of risk management compares with similar risk assessment and management processes in other aspects of social activity such as leisure pursuits, road safety or the construction industry for example. Quite clearly, basing risk assessments solely on economic criteria, or on economic and social criteria as the large infrastructure projects such as SMHS were, is no longer acceptable. Increasingly, even though a large section of the (metropolitan) community requires increasing quantities of potable water without additional cost imposts, the maintenance of environmental values is also socially and culturally significant. The authors of this paper seek to demonstrate that the trimorphism of TBL, i.e., the interconnectedness of economic, social and environmental values complemented with a holistic risk assessment process is the only process sufficiently sensitive and comprehensive to meet government and the broader community's environmental requirements.

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