

# Water Needs Assessment: learning to deal with scale, subjectivity and high stakes

Kim S. Alexander<sup>a\*</sup>, Magnus Moglia<sup>b</sup>, Craig Miller<sup>c</sup>

<sup>a\*</sup> CSIRO Sustainable Ecosystems, Gungahlin, Canberra, ACT, 2911 Australia  
[Kim.Alexander@csiro.au](mailto:Kim.Alexander@csiro.au) (m) +61409 092 525 (fax) +6162421705

<sup>b</sup> CSIRO Land and Water, Highett, Melbourne, VIC, 3190 Australia  
[Magnus.Moglia@csiro.au](mailto:Magnus.Moglia@csiro.au) (m) +61425 748 834

<sup>c</sup> CSIRO Sustainable Ecosystems St Lucia, Brisbane, QLD 4067 Australia  
[Craig.Miller@csiro.au](mailto:Craig.Miller@csiro.au) (m) +61419 653 747

## Abstract

Water issues are inherently local and inter-dependent and almost fully reliant on the interaction between humans and their socio-technical environments. Hence, the development of water management policies requires evidence-based information that deals with complex, contextual and multi-faceted issues. Composite indicator methodologies have been found to be useful tools supporting policy development and decision making in several fields. Targeted water management decisions can benefit from indicator methodologies that combine statistical and qualitative information to assess water issues and rank the differing ‘needs’ of locations. However, due to limitations, we argue that indicator methodologies are best supported by a broader deliberative process of engagement, involving in-depth exploration of issues using inclusive and collective learning processes.

In this paper, an integrative and deliberative process is described and applied to understand and evaluate watershed resources and management in the Tigum-Aganan Watershed, Philippines. Collectively, local knowledge from stakeholders and quantitative information have been used in developing the Water Needs Index, providing data and informing the selection of data sources for use in the index methodology. In subscribing to the exchange of descriptive narratives we achieve a greater degree of context dependence, transparency and stakeholder participation in the assessment process. Whilst our assessment of the usefulness of the composite methodology is subjective, we believe that the methodology shows great promise; in particular in supporting the emergence of collective action.

**Keywords:** indicator methodology, post-normal methodologies, deliberative process, water management decisions, water policy

## 1.1 Introduction

The world faces a global water crisis, due in part to endemic over use of water resources and to climate change (Arnell, 2004; Vörösmarty et al., 2000), as exemplified by the often severe situation in small island states such as Kiribati (Moglia et al., 2008b), or that of water related conflicts on the Ganges (Bhaduri and Barbier, 2008), or the increased pressure on livelihoods and impacts on food production in the Mekong River Basin (Keskinen et al. 2009).

Consequently, governments require evidence-based processes to assist in prioritizing development investments for water infrastructure and allocation. This study was motivated by the need to provide a process suitable for use in development activities and for international aid organisations.

The method described in this paper was initially developed to assess national water needs for the Australian Government's official aid organisation (Moglia et al., 2008a). High level policy officers within donor agencies were the initial target user group supposedly requiring water needs assessments to support their policy decisions. However, as the project progressed it became clear that the method was in fact more suitable for application by local water managers.

We recognized that water management situations are diverse and reliant on complex interactions between natural systems, technical systems and social systems. While some variables are critically important to water management, such as availability of water and accessibility to water, these variables are often difficult to measure. An indicator approach provided a solution, given the complexity and inadequacy of data at the local scale.

A review of the literature identified that indices are commonly used to assist in making water management decisions; however, there are a number of potential problems when taking this approach. These problems relate to the fact that the decision situation is often contentious, with high stakes involved, both in terms of livelihoods and finances, but also in terms of cultural identity and power regimes. Furthermore, the decision situation is complex, made within the nexus of interactions of social, natural and technical systems. Consequently, indexes often struggle to adequately account for the complexities underlying decision making.

Molle and Mollinga (2003) claim index methods are often used by centralised bureaucracies to achieve legibility and simplification and go on to raise concerns about accuracy and reliability of indicator methods. In particular, they query the exceedingly subjective process of populating an index with dimensionless data sets and weights. Barnett and colleagues (2008) acknowledge such criticisms but argue that indicators are efficient and effective for local water planning assessments rather than for national or international assessments. They suggest that indicators should not be used for policy analysis in many contexts, but rather efforts be made to incorporate knowledge from experts into assessments. This is supported by Reed et al. (2005) who emphasise the importance of participatory approaches at local scales to develop indicators that are scientifically rigorous and remain objective while using easily collected data with results interpreted by experts and disseminated in stakeholder communities. Furthermore, Singh et al. (2009) suggest composite indexes are useful in simplifying, quantifying, analysing and communicating otherwise complex and complicated information.

After consideration and discussion with colleagues, we made a pragmatic decision to proceed with an indicator approach to meet the express need of the international aid organization. To further support this process, we chose to embed the index method within a deliberative framework in order to engage dialogue and thereby promote transparency and incorporate expert knowledge. This allowed us to reduce the level of subjectivity in the choice of dimensions, data sets and weights.

The deliberative framework uses a post-normal scientific approach, useful when all factors are not necessarily knowable and where accessing all relevant information is too time consuming or unclear and affected by high levels of uncertainty (Funtowicz and Ravetz 1993). Where stakeholders hold disputable values, stakes are high and urgent decisions are

required, post-normal methodologies can supplant conventional methods of inquiry. By taking a constructivist post-normal approach, the decision outcomes are based on subjective value judgments. This allows for multiple voices and many interpretations of the situation. By taking this approach, any assessment and decision can be collectively agreed upon and owned by stakeholders before action can be taken.

This paper describes how the Water Needs Index was developed and applied in a number of different circumstances. In particular, the paper describes the application of the method to the Tigum-Aganan Watershed in the Philippines.

## 2.1 The Water Needs Index

The initial Water Needs Index (WNI) was developed within an index framework, drawing on the Climate Vulnerability Index (Sullivan and Meigh, 2005), an extension of the Water Poverty Index (Sullivan, 2002). The aim of the WNI was to determine the water needs of a specific location by incorporating the physical, economic and social drivers linking water and poverty. The approach is based on a selection of indices used to identify symptomatic water issues and identify hotspots requiring attention. We chose to apply the more constructive term ‘Needs’ rather than the potentially pejorative term ‘Poverty’.

The WNI has six dimensions - Resources, Capacity, Use, Access, Environment and Vulnerability, as defined in Table 1. Each typically is constructed from a number of sub-indicators, examples of which are listed in Table 2.

**Table 1 Definition of dimensions used in Water Needs Index assessments**

Dimensions	Definition of dimension
Resource (R)	The physical availability of surface and ground water, including variability and quality of the resource as well as the total amount of water.
Access (A)	The extent of access to water for human use, including access to irrigation.
Capacity (C)	The effectiveness of people’s ability to manage water
Use (U)	The efficiency of water use for domestic, agricultural and industrial purposes
Environment (E)	A measure of human water use impacts on the ecological integrity
Vulnerability (V)	A measure of the degree of risk arising as a result of the physical or geographical nature of the selected location

The calculation of an index is based on its dimensions using a weighted average:

$$WNI = (R \cdot w_R) + (C \cdot w_C) + (U \cdot w_U) + (E \cdot w_E) + (A \cdot w_A) + (V \cdot w_V) \quad (1)$$

Each of the dimension values lies between 0 and 100, and the weights are all between 0 and 1 and add up to 1 as per Equation (2).

$$w_R + w_C + w_U + w_E + w_A + w_V = 1 \quad (2)$$

The individual dimension values (R, C, E, U, A and V) are in turn calculated using underlying data sources. Such data sources are normalized in a linear fashion and this generates values between 0% and 100%. Detailed information on the calculation of the index is available from project reports and conference articles by Alexander et al. (2009a, 2009b) and Moglia et al. (2008a).

The initial applications of the WNI were at (i) a national scale for a number of countries in the Asia Pacific region, (ii) multiple scales within the Mekong region basin, and (iii) the scale of the populated islands of the country of Kiribati in the Equatorial Pacific. Multiple data sources were typically used within each dimension, as described in Table 2. More detail on how these values were included is provided in the report by Moglia et al. (2008a).

**Table 2: Examples of data sources used for initial Water Needs Index assessments**

Dimension	National scale assessment	Mekong river basin assessment	Kiribati island assessment
Resources	<ul style="list-style-type: none"> <li>- Average annual rainfall</li> <li>- Total renewable water resources per capita per year</li> <li>- Dependency ratio (% of total renewable water that originates from outside of country)</li> </ul>	<ul style="list-style-type: none"> <li>- Water available per capita</li> <li>- Average annual rainfall</li> <li>- Coefficients of variation</li> </ul>	<ul style="list-style-type: none"> <li>- Average annual rainfall</li> <li>- Estimated sustainable yields</li> <li>- Coefficient of variability</li> <li>- Expert rankings of water related health issues</li> </ul>
Access	<ul style="list-style-type: none"> <li>- Access to improved water services (rural and urban)</li> <li>- Access to improved sanitation services (rural and urban)</li> </ul>	<ul style="list-style-type: none"> <li>- Access to clean water</li> <li>- Access to sanitation</li> </ul>	<ul style="list-style-type: none"> <li>- Access to improved water services</li> <li>- Access to improved sanitation services</li> </ul>
Capacity	<ul style="list-style-type: none"> <li>- Adult literacy rates</li> <li>- GDP per capita</li> <li>- Foreign aid as a percentage of GDP</li> <li>- Political rights</li> <li>- Amount of development assistance per capita per year</li> </ul>	<ul style="list-style-type: none"> <li>- Employment rates</li> <li>- Literacy rates</li> <li>- GDP per capita</li> <li>- Foreign aid as a percentage of GDP</li> </ul>	<ul style="list-style-type: none"> <li>- Employment rates</li> <li>- Expert ranking of quality of facilities</li> <li>- Ratios of land ownership</li> <li>- Expert ranking of institutional strength</li> </ul>
Use	<ul style="list-style-type: none"> <li>- Use of domestic water for crops production</li> <li>- Water withdrawal for domestic use</li> <li>- Total consumption</li> </ul>	<ul style="list-style-type: none"> <li>- Child malnutrition</li> <li>- Poverty rate</li> <li>- Employment in agriculture</li> <li>- Annual production of paddy</li> </ul>	<ul style="list-style-type: none"> <li>- Access to various crops</li> <li>- Household water budgets</li> </ul>

Environment	- Loss of natural vegetation - Environmental protection treaties - Population density	- Population density - Annual deforestation rates	- Solid waste collection coverage - Population density - Expert ranking of water resource protection
Vulnerability	- Vulnerability to climate change - Exposure to natural disasters - Isolation	- Changes in run-off rates	- Distance from closest urban area - Size of island - Predicted changes in rainfall

Several lessons were learnt through these applications including:

- Difficulties in accounting for spatial and temporal variability, particularly at larger scales;
- Reductionism tendency, providing overly simplified and deterministic explanations of complex and uncertain dynamics;
- Difficulties making direct comparisons especially when data provided by individual countries is often collected in very different ways, with questionable acuity ;
- Data scarcity, there is generally fairly poor data availability for many areas and regions and it is unavoidable to have data gaps. For example, there is relatively little data available for the Pacific Islands region;
- Expert rankings and judgments can provide very valuable information;
- The choices of data sets as indicators as well as the weights for the index are strongly dependent on the skills, experiences and perspectives of the researcher.

The difficulties that emerged in these applications related mainly to primary data quality, scale issues and legitimacy.

### 2.1.1 Legitimacy

There is a real need to address the issue of legitimacy of indicator assessments, and to acknowledge the political nature of many index applications. Sullivan et al. (2002) concede that an index may have a political rather than statistical purpose, while Streeten (1994) claims the benefit of indices is to simplify and focus attention on an issue. Yet indices can also be useful in de-politicising and de-contextualising problems and they can be used to infer appropriate actions to initiate research, investment or reforms (Srinivasan, 1994). Lindholm et al. (2007) suggest that honest and objective appraisals of critical parameters are essential to inform selection and interpretation of analysis when using indices for any purpose.

However, results of assessments can also provide significant insights, and help in conveying complex messages to policy and decision makers.

### 2.1.2 Data quality

Global and regional data sets are readily available and provide an important conventional information source for populating the WNI dimensions. However, data sources may be contested on the grounds of (i) suitability, (ii) representativeness, (iii) method of collection, frequency and date of data collection, (iv) origin of source, (v) implications of the value, (vi) reliability, (vii) scale of reference, (viii) temporal reference, (ix) geographical limitations, (x) level of subjectivity, and (xi) misuse of average values (Alexander et al., 2008).

For example, the Total Actual Renewable Water Resources (TARWR) provides an estimate of the maximum theoretical amount of water resources in a country, and indicates the average annual per capita volume available to individuals within the country (FAO, 2003). UNESCO (2006) uses water resource statistics collected by FAO (2003) from national sources that have been reviewed to ensure consistency. They found that dubious or undocumented methods and assumptions and/or extrapolations were used to compute estimations of the individual components of the water balance in many instances. There were also multiple sources of information and different periods of reference that varied from country to country.

### **2.1.3 Scale**

Data sources such as the TARWR tend to become less meaningful when applied at a larger scale. For example, consider applying TARWR to Australia. As a whole, Australia has a relatively small population in comparison to land mass, and despite much of the continent being covered by desert, there are also considerable amounts of water in remote locations, particularly in Northern Australia. In this situation, the TARWR does not represent the fact that water is difficult and costly to transport to those locations that are in need; i.e. in particular south-eastern and south-western Australia, or to those farmers whose farms who have survived despite years of drought. However, it becomes more meaningful if applied at a localised scale.

## **3.1. Theoretically combining methods**

We recognised the utility and limitations of the indicator approach and decided to determine whether the WNI could be complemented with qualitative discursive methods from social science.

Creswell (2009) suggests post-normal, adaptive methodologies combining quantitative with qualitative methods of research are useful in situations where complex social, economic and biophysical research is conducted (Creswell, 2009). An applicable mixed method approach is to integrate qualitative and quantitative research using a ‘dominant-less dominant design’ (Creswell, 2009). The ‘dominant’ research paradigm in this research is a quantitative approach conducted by numerically comparing and contrasting indicator method values (using average or scaled information) for countries and regional areas.

Quantitative methods differ from qualitative methods in terms of their ontological, epistemological, axiological, rhetorical, and methodological perspectives (Johnstone, 2004). The quantitative paradigm tends to assume independence from those being researched, but there are exceptions as for example in the post-modern participatory tradition as represented by Barreteau and colleagues (2003). Quantitative methodology is often a deductive, statistically designed process and used to formulate generalizations that lead to predictions, explanation, and understanding (Johnstone, 2004). As such, results based on quantitative

approaches are usually presented as unbiased and value-free findings. In this way, reality is typically considered objectively, depending on the studied system, thought to be predictable (logical positivist). In this research, the constructed WNI has been used to represent the physical availability of water and is a numeric construction, implicitly unbiased and value-free.

The 'less-dominant' qualitative research paradigm in this study is interpretive with a social constructionist perspective. This allows the development of understanding of the culture, context and the inherent social relations within the study area by inclusion of stakeholders' opinions (Neuman, 2000). The ontological assumption is that there exists subjective and multiple realities among those participating. The use of qualitative methods enables an interactive, adaptive and participatory approach, often practiced less formally and which legitimizes value-laden, context-bound, biased reporting (Creswell, 2009; Johnstone, 2004). Methodological triangulation using qualitative and quantitative methods allows for access to a wider variety of information, increases validity and reliability, and is used to overcome deficiencies of single-method approaches (Neuman, 2000).

In the next section we present a way to combine quantitative and qualitative methods for indicator projects.

### **3.1.1 Dealing with high stakes, subjectivity and scale**

Deliberative qualitative approaches can overcome some inherent difficulties encountered in the application of indicator approaches (e.g. Abelson et al., 2003; Patton, 2002). Deliberative qualitative approaches can be used to assist in promoting the validity, transparency and appropriateness and, via knowledge elicitation, to ensure that the data is representative of the diverse and complex locations and management regimes that are often encountered. In other words, the overall aim of developing an indicator methodology incorporating a deliberative process is to:

- Improve the legitimacy of assessments by engaging with a wider group of stakeholders to incorporate more representative values and perspectives, in particular engage with those stakeholders whose cooperation is needed for the co-construction of solutions;
- Avoid a situation of potential corruption where single individuals or groups of individuals, are in a situation of hidden and significant influence;
- Better incorporate expert knowledge in order to encapsulate very complex local contexts.

Combining quantitative methods within deliberation is done within Participatory modelling, and evaluations of these types of approaches have been shown to a) improve legitimacy b) integrate different types of knowledge and c) provide better process and reduce conflict (Jones et al 2009).

In a similar vein, the combination of an indicator approach with a deliberative qualitative approach has been developed by the project team (Alexander et al., 2008; Moglia et al., 2008a). The process is:

1. Identification of relevant stakeholders; i.e. determine who has a significant enough stake so that they warrant involvement in the process?

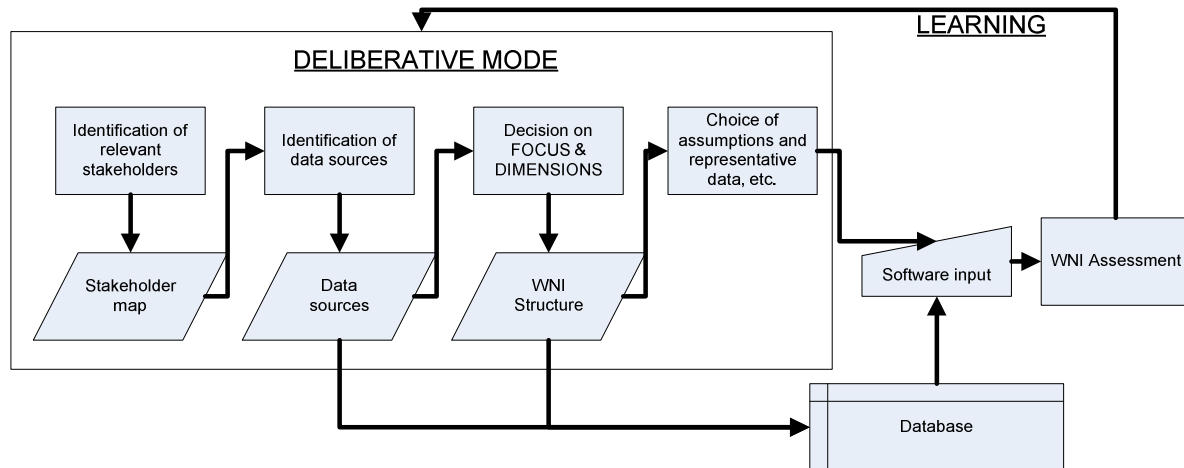
2. Identification of data sources; i.e. what data do we have in order to make any statements about the state of affairs in particular locations;
3. Decision on problem focus and dimensions in conjunction with stakeholders; i.e. what do we want to achieve with the assessment (e.g. addressing food security, water quality, or water service issues, etc) and deciding on the key dimensions that are important for understanding the particular goal;
4. Choice of assumptions and representative data; i.e., how we can best represent the chosen dimensions with the limited and uncertain data that we have, and how to best acknowledge this uncertainty;
5. Application within the WNI framework; which creates an output in terms of overall rankings of needs which can be visually displayed for each location.

We also believe that it is of critical importance that this approach is applied at the appropriate scale, where each indicator incorporated into the index should make sense and not provide an aggregation which completely dilutes the usefulness. The indicator should be applied at a scale for which it is possible to have relevant and representative stakeholders present in a workshop setting. This is not possible for an international comparison of water needs in different countries, but would be possible at catchment scale when there is a finite set of important stakeholders and localized cultural, economic and social homogeneity within the geographical units.

An important aspect of this method is its capacity to allow collaborative learning to take place through interactive planning and knowledge management in the deliberative process (Fig. 1). International aid organisations, non-governmental organisations (NGOs), community leaders, government departments, water utilities and river commissions could use the process to inform water management in their areas of interest. Approaches can be developed to involve stakeholders as advisors where reliable data are not available.

Furthermore, drawing upon post-normal thinking we argue that the benefit of using a deliberative process to assess and rank water needs is the improved ability to make strategic decisions at temporal and spatial scales where global data sets are often unable to supply adequate and appropriate details. An engagement process where stakeholders deliberate over water issues allows for flexibility and greater adaptive capacity in decision making (Reed et al., 2005). The authors suggest the incorporation of a deliberative process promoting inclusive discussions, and that illustrate contextual issues provides a greater degree of analysis and an ability to better inform the index construct by providing a mechanism for the inclusion of qualitative information.

As shown in Figure 1, the deliberative mode is a critical component in the WNI approach. A Delphi process forms the basis of the deliberative mode in order to formally incorporate multiple and conflicting perspectives and allow consensus to emerge for contentious issues. This requires the development of a stakeholder map reflecting the interests, opinions and knowledge of water needs amongst the stakeholders (Fig 1).



**Figure 1: Water Needs Index Assessment process. Source: Adapted from Alexander et al. (2008)**

The Delphi process is a method for structuring group communication processes such that a group of individuals, as a whole, are able to deal with a complex problem (Linstone and Turoff, 2002). A Delphi process may involve between 10 and 50 participants, selected on the basis that they are experts, practitioners and stakeholders with considerable experience on the topic in question and able to reflect a wide range of views and perspectives in a meaningful exchange of ideas. The Delphi process can be conducted in many different ways, e.g. conference telephone call, committee meeting, formal conference or seminar, workshop, email or internet process (Linstone and Turoff, 2002; Proctor and Drechsler 2006; Rixon et al., 2007).

Okoli and Pawlovski (2004) describe several steps in the process of interactions with participants as (i) selection of participants and assignment to panels, (ii) brainstorming sessions, (iii) response classification, (iv) selection of factors, and (v) ranking factors. Under these circumstances, the personal bias of the researcher facilitating the process is unavoidable. To minimize this bias, the process involves iterative participant validation of the categorizations and rankings, and invitations to provide feedback on the process (with adjustment of the process when considered appropriate). For learning and validation purposes, there is also a focus on identifying and discussing inconsistencies and disagreements between participants, thereby modifying the collective action framing.

#### 4.1 Case study: does it work?

The Tigum-Aganan Watershed (TAW), Panay Island, Philippines, provides water for a population of over 400,000 people, including the residents of the port city of Iloilo. In 1989, a study by the Department of Environment and Natural Resources (DENR) concluded that the watershed would be unable to meet the water requirements of the city, the surrounding municipalities, and agriculture into the future (Salas, 2004). In 2000, the Tigum River ceased flowing, causing the city to lose its main water supply for some months, and in 2002, water rationing during summer was introduced and has continued every year since. The dry seasons of 2006 and 2007 were particularly harsh, lasting for up to 10 months (Salas et al., 2009).

Watershed stakeholders established a multi-sector body called the Tigum-Aganan Watershed Management Board (TAWMB) in 2000, in response to a history of watershed management

issues and the cessation of flow in the river (Salas et al., 2009). The Board continued to move and adopt measures the stakeholders hoped would achieve integrated catchment management (ICM) through democratic environmental governance, often challenging the authority of the DENR in the process. The TAWMB identified the lack of shared understanding regarding the ecology, hydrology, and institutional agendas of various government agencies and non government agencies as key stalling points in developing their environmental strategies and achieving ICM.

At the invitation of the TAWMB we ran a five day workshop in Iloilo to examine watershed issues, during which time we applied the WNI with the deliberative approach to comparatively rank the *water needs* of the governance areas within the watershed (Fig. 1). Stakeholder groups discussed and re-framed the issues during the workshop. The aim of the workshop was to promote common understanding or co-framing of water issues amongst stakeholders of the eight municipalities and one city department in the Tigum-Aganan Watershed and provide scientific and technical methods to assist stakeholders in making good water planning decisions. Reflection on goals, assumptions and priorities, and reframing in the context of shared learning, is an important social learning process, and is pivotal to the development of a sustained capacity of effective river basin management by authorities, experts, interest groups and the public (Pahl-Wostl, 2009).

During the process a ‘champion’ (a municipal mayor) guided up to 32 workshop participants to agree on and clarify the purpose of the metrics by deliberating on the focus of the output, prior to discussions of appropriate data sources for inclusion in the *water needs* deliberations. In doing so, the data concerns were highlighted and assumptions clarified, finding ways to minimize data gaps and the use of data with low certainty. The process entailed eliciting diverging opinions (i.e. brainstorming) followed by conversations that allowed for convergence towards a shared understanding, with an iterative feedback capacity to further inform discussions. Through this process selection of indicators and sub-indicators was established. Issues and concerns were raised in-depth in discussions on Resources, Environment and Vulnerability indicators, with less identified for Access Capacity and Use as these parameters were more difficult to define and required more specialized knowledge. Quantitative data were included for Resource, Access and Capacity values to assist in computing the final scores.

#### 4.1.1 Findings

Table 3 displays the calculated dimension weights and the ranked WNI values according to formulae presented in Section 2. The relative value (weighting) of each dimension has been adjusted by participant scoring of the relative importance of each dimension in assessing *water needs*. The WNI values were then calculated using the factor weightings, additional quantitative data and these values were re-scaled according to the weighting for each dimension. We considered that ratings applied for each Municipality represented the real situation because of the expertise of the workshop participants, but ensured that local biases were compensated for by group evaluation.

The WNI scores range from 0.17 to 0.65 (maximum value is 1.0), where low scores indicated more problematic areas, as in Pavia, Leon and Iloilo City and hence greater *water needs*. These townships and city are located on the flatlands and subject to flooding events, with inundation of water tables from flooding during typhoons when river volume surges. Water quality and sanitation are problematic, in these areas of highest populations. Maasin and

Alimodian are in the uplands; affected by flash surging headwaters, lower populations, land slides and river quarrying that influence water quality. Oton has abundant groundwater, is on the lowlands and has fewer environmental and vulnerability issues. Alexander et al. (2009b) provides a full account of the research analysis.

The benefit of constructing a WNI and ranking municipalities with participants has been the sharing of knowledge and information between local experts and with researchers using a simple, understandable and flexible approach to gathering data, opinions and deliberatively exploring topics. The effectiveness of the WNI approach has been to open dialogue and improve understanding of the functioning of the watershed in different municipalities, exploring the ability to access quality water and the problems arising from natural hazards, particularly flooding events, in maintaining supplies of water. The process allowed the researchers to understand more about the beneficiaries involved, the differing interests, and whose concerns, values, knowledge and systems of legitimacy were included, excluded or marginalised. Short meetings with a number of municipal mayors, the Regional Executive Director of the Department of Environment and Natural Resources and the Provincial Governor indicated some political interest in the process.

**Table 3 Weighted dimensions and WNI scores and rank**

Municipality	Resource	Access	Capacity	Use	Environment	Vulnerability	WNI	Rank
Pavia	0.38	0.30	0.01	0.00	0.33	0.00	0.17	1
Leon	0.33	0.48	0.26	0.00	0.00	0.50	0.26	2
Iloilo City	0.40	0.50	0.50	0.50	0.17	0.00	0.34	3
Maasin	0.53	0.38	0.38	0.00	0.17	1.00	0.41	4
Alimodian	0.53	0.38	0.25	0.50	0.83	0.00	0.41	5
Santa Barbara	0.00	0.40	0.39	1.00	1.00	0.00	0.46	6
Cabatuan	0.55	0.40	0.51	0.75	1.00	0.00	0.53	7
San Miguel	0.71	0.50	0.38	1.00	1.00	0.00	0.59	8
Oton	1.00	0.50	0.39	1.00	1.00	0.00	0.65	9

In order to make this process a widely adopted resource there is a need to engage the resource decision makers and facilitate planning that incorporates the knowledge gained through the *water needs* process of ranking and identifying key areas of concern in municipalities. Re-framing of collective action may allow for the development of more integrated policies that identify and favour measures that deliver multiple benefits, taking into account the preferences of a wider range of stakeholders. Success factors for better policy development include engagement of senior political leaders, cyclical and adaptive policy development (such as five year plans), multi-agency and stakeholder processes, and stronger accountability and enforcement measures. This is supported by Pahl-Wostl (2009) who claims the relative strength of formal and informal institutions impact on the adaptive capacity of governance regimes.

## 5.1 Conclusions

Index methods provide a valuable way to inform international investment decisions by aid agencies, and government officials at local or regional levels. Reviews of literature, research experiences and data sources suggest the need for careful consideration of data selection and the use of deliberative processes and adaptive methodologies to improve the transparency, capability and accuracy of the index methodology to inform water management decisions. The Water Needs Index, incorporating a deliberative assessment process, provides decision makers a richness and depth of information not normally achieved by an index based on statistical data. This also provides stakeholders an opportunity to participate in informing the decision making process, as well as promoting common understanding and collaborative learning.

Problems associated with accessing reliable data abound when developing indices. Our review of the methodological literature suggested to us that post-normal approaches would be a useful accompaniment to the WNI where there were high levels of uncertainty, unknown or unknowable factors, and insufficient time to collate statistical information, disputable values, and/or where the stakes were high with urgent decisions required. Qualitative methods enable the use of deliberative and participatory processes, and are more inclusive and iterative in nature. Participatory enquiry is recommended within the research process when information is required for assessments in smaller countries and when conducted at community (micro) level. This also allows re-framing of issues facilitating the actors in influencing decision making (Pahl-Wostl, 2009). The subjective nature of this approach, however, requires an increased level of transparency in the decision making process.

One benefit of using an integrated approach for water management decisions is the capability of making evidence-based decisions at micro-scales, i.e., locally and regionally, where data are not necessarily available. This technique increases the ability to identify the symptomatic water issues and hotspots requiring attention. Suitable intervention strategies can be identified for different local contexts and circumstances, given adequate information. Collaborative learning can take place through interactive planning and knowledge management in the deliberative mode of the process, involving a wider range of stakeholders. Broadly, water management strategies can be developed by international aid organisations, non-governmental organisations (NGOs), community leaders, government departments, water utilities and river commissions using this adaptive and deliberative methodology.

A second benefit of using a deliberative process is the improved ability to make strategic decisions at temporal and spatial scales where commonly, global data sets are unable to supply adequate and appropriate details. An engagement process with stakeholders allows for flexibility and greater adaptive capacity in decision making. The authors suggest that the incorporation of the deliberative process provided a greater degree of analysis and an ability to better inform the index construct through a mechanism for the inclusion of qualitative information. Many water issues are bound by local knowledge and access to all relevant information is too time consuming or unclear due to high levels of uncertainty. Consequently, the use of post-normal methodology through a deliberative process, mindful of framing, increases the scientific rigour and allows for an adaptive capacity in the development of the index methodology. As a result the deliberative process allows those involved to better understand and allow for socio-economic issues in highly politicised water management environments.

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