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Opening up the Water Poverty Index

- co-producing knowledge on the capacity for community water management using the Water Prosperity Index

Running Head: Opening up the Water Poverty Index

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Abstract

The Water Poverty Index is a tool enabling a multi-sectoral description of the water situation in an area or region. Many aspects of a society's capacity to manage water, however, require qualitative and explorative approaches. Additionally, the perceptions of “the water poor” themselves may differ substantially from expert valuations built into the Water Poverty Index. The aim of this paper is to open up the Water Poverty Index with a special focus on the capacity to manage water in a robust way. This is done through a process of participatory research and by transforming the Water Poverty Index into a Water Prosperity Index using a local community in Central India as example. By opening up the assessment process, issues empirically identified by community members, researchers and local NGO-staff can be discussed and qualitatively assessed, resulting in an improved knowledge of the water situation and an approach for participatory planning.

Keywords: Water Poverty Index WPI; institutional capacity; systems for learning; participatory research; “opening up”; Water Prosperity Index WPI⁺

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1. Introduction

Access to adequate clean water is essential for health, in livelihood generating enterprises, to promote food security and for ensuring the sustainability of ecosystems (UNWWD, 2003; Rijsberman, 2000). As populations strive for higher standards of living, increased pressure on limited and decreasing water resources also increase the climate vulnerability of regions, nations and local communities (IPCC, 2007). Thus, methods enabling a better understanding of the relations between human "well-being", water resources availability and use, and, in a longer time perspective, how these may be affected by climate change, are required. A common approach to this is the development and use of indices (Molle and Mollinga, 2003, Mayer, 2008). The Water Poverty Index (Sullivan 2002, Sullivan et al., 2003, Sullivan and Meigh, 2003, 2005, 2007), combines five components related to water (resources, access, use, capacity to manage and environment) to give an indication of inhabitants' welfare in relation to water. While the resource and environment components mainly deal with physical factors relating to water quantity and ecosystem health, the access, use and capacity components recognise that the quantity of available water is not always exclusively the problem.

Apart from various water and sustainability indices (a systematic review by Plummer et al (2012) revealed the existence of at least 50 water vulnerability assessment tools) other well-

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known national indices also exist (e.g. the Human Development Index). Although their inherent limitations restrict their usefulness (Molle and Mollinga, 2003) they continue to guide policy making at various levels and their use is not likely to diminish in the future. Thus, in order to make their usage more meaningful there is a need to explore to what extent such indices may actually reflect local circumstances.

The apparent strengths of applying the Water Poverty Index as an assessment framework lie in its multidimensional approach, assessing both soft and hard dimensions of the water situation in the studied area. Moreover, it can fulfil the role of providing a tangible, common framework around which researchers, local inhabitants, NGOs and water-related authorities can meet, discuss and plan for holistic water management and increased well-being of the concerned population (Molle and Mollinga, 2003). However, for it to function well in this boundary spanning between scientists, policy-makers and local stakeholders, the components and indicators need to be well understood and be based on water issues prioritised as important by the “water poor” themselves, something that few, if any, of the previous studies of Water Poverty Index at community scale have realised to a great extent. This paper describes and analyses the process of opening up the Water Poverty Index (WPI) into a Water Prosperity Index (WPI⁺) by involving people from a local community in Central India in the assessment of their water situation. We do so with specific focus on the capacity component, since there are calls for more research on the softer dimensions of socio-ecological systems, such as systems for learning and social capital, etc. (Folke, 2006) and the behaviour, knowledge and skills of the people involved in governance systems (Fazey et al, 2007, Pahl-Wostl, 2009).

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The WPI capacity component aims to provide an assessment of “*the ability of a society to manage water resources*” (Sullivan and Meigh, 2007). While this ability is said to depend on level of education, health and access to finance in a society, it also encompasses community level skills to effectively manage water, to lobby for improvements, and the presence and effectiveness of water users associations (WUAs) or other organizations (Sullivan and Meigh, 2003, 2007, Sullivan et al., 2003). However, the capacity indicators used in the WPI (i.e. literacy rates, under-five mortality rate, income levels, ownership of durable items, % of households with one person employed and membership in Water Users Associations) only partly reflect these dimensions.

The ability of a society and its individuals to manage available water resources is determined by a vast array of institutional arrangements, societal values and strategies, and feedback mechanisms between social and ecological systems. The case of a local community, i.e. a village, could be understood as a micro socio-ecological system whose “well-being” to a large extent depends on how available water resources within a larger multi-level institutional and hydrological context are managed. Moreover, limited water resources are commonly used (even if not commonly managed), and thus the interplay between local common property resource management and centralised formal management structures highlights the importance of strengthening local capabilities and a conducive higher-level institutional context (Agarwal and Ostrom, 2001, Carlsson and Berkes, 2005). Consequently, research focusing on management institutions, how they evolve, are upheld and which outcomes they have in terms of sustainable natural resource management is highly relevant.

Strong arguments in favour of increased stakeholder participation in water and natural resources management have been raised, as the involvement of representatives from various

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societal sectors in the research process can enrich the knowledge base through a process of *co-production*, where “*concerned groups*” *get actively involved in the process of knowledge production of direct use for them*” (Felt and Wynne, 2007:55). For issues involving high uncertainty or risk, the inclusion of the expertise and knowledge of lay stakeholder groups will enhance the quality of scientific risk assessment, and increase society’s ability to deal with unforeseeable contexts (Gasparatos et al, 2009, Felt and Wynne, 2007, Tripathi and Bhattarya, 2004). Stirling (2008) argues that “closed” assessments using traditional analytical tools often are too narrow, rigid, quantitative and expert-based. To complement these assessments, an approach that “*poses alternative questions, focuses on neglected issues, includes marginalized perspectives, triangulates contending knowledges, tests sensitivities to different methods, considers ignored uncertainties, examines different positions and highlights new options*” (Stirling 2008:280) is suggested. Thus, the WPI could benefit radically by being modified into a WPI⁺ by including non-experts to enable the inclusion of local and lay knowledge (Molle and Mollinga, 2003, Sullivan and Meigh, 2007).

The overall aim of this paper is to open up the Water Poverty Index with a special focus on the capacity to manage water in a robust way. This is done through a process of participatory research and by transforming the Water Poverty Index into a Water Prosperity Index using a local community in Central India as example. By “opening up” the assessment process, issues empirically identified by community members, researchers and local NGO-staff are discussed in terms of natural resource management theories. Moreover, differences in approach and results of the community-created WPI⁺ based on locally defined indicators and more qualitative data with the mostly expert-dominated WPI largely based on existing quantitative data are discussed. While both the WPI and the WPI⁺ aim to give an indication of the state of inhabitants’ welfare in relation to water, the WPI⁺ does so from a new starting point, i.e. water

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prosperity rather than poverty. The focus in this paper is to contribute to a richer understanding of the relation between a community's "well-being" and the water management capacity component in the WPI. We hope to fulfil three specific aims:

- To "open up" the capacity component in a co-production process involving community members, NGO staff and researchers. The opening up enables an identification of the most important capacity related factors determining community water "well-being" and suggests how they could be assessed by local stakeholders (Section 3).
- to summarize co-produced findings on the capacity component for inclusion in the community verified Water Prosperity Index, WPI⁺. This enables a comparison between the descriptive value of the original WPI and the new WPI⁺ (Section 4).
- to briefly describe and reflect on the conditions and results of the co-production process (Sections 2 and 5).

2. Methodology

A rural community of approximately 100 households in Central India was chosen. Initial contact with the community was made through an Indian NGO working locally with irrigation management (with WUAs) and self-help groups (SHGs) to empower poor women through micro-credit schemes. The NGO, funded from both national and international sources, is engaged in various activities focusing on creating sustainable livelihood opportunities for the poor. Our introduction to community members was enhanced by their earlier positive NGO-experiences, so that the NGO was in a double position of gatekeeper and boundary spanner between us and the villagers.

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The community, situated in Vidisha district, Madhya Pradesh, with average annual rainfall of 1100 mm/year, depends on a water supply from the Samrat Ashok Sagar Irrigation scheme for its wheat crop. Community members include land owning farmers¹ growing irrigated wheat and rain fed soya bean, and landless people who work as wage labourers in agriculture and other trades. The community can be distinguished into two parts; one relatively prosperous and inhabited by a mix of castes; i.e. the Village; and another considerably less prosperous, inhabited primarily by members of scheduled castes; i.e. the Hamlet. 100 % of men in the Village own agricultural land, compared to 72 % in the Hamlet.

2.1 Opening up the WPI

Between 2006 and 2009, four field trips were undertaken and altogether 16 workshops arranged. With the help of the NGO, 14 gender-separate participatory workshops (7 with women and 7 with men) were held, attracting participants from the WUA, which encompassed all landowners and the SHGs, to which the majority of Hamlet women belong. The SHGs do not specifically work with water issues, but all community women are however responsible for procuring household water. Two larger gender-mixed workshops with attendance by community members and local government officials within the areas of health, irrigation and rural development were also arranged to allow an interactive dialogue between government and inhabitants on prioritised water issues. A variety of Participatory Poverty Assessment tools (PPAs) (Norton et al, 2001), such as drawing of maps, ranking exercises, etc., were used in the workshops to stimulate knowledge sharing and structure discussions.

¹ Landownership indicates having land rights.

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As participation based on these organizations meant an under-representation of women from prosperous households in the Village, and landless men from the Hamlet, these groups were targeted separately to incorporate the perspectives of a wider range of community members. Thus, approximately 40 informal interviews with community members, local NGO staff and government officials at the district level, participant observations, group discussions as well as social visits were employed in way inspired by grounded theory field work. This systematic verification and re-verification of the results was an explicit part of the approach. The main methods of documentation were field notes, documentation from exercises, photos and drawings.

For the capacity component, we chose to focus on the community's capacity to manage their water resources rather than on their health and financial "well-being". Though income and health are undoubtedly factors vital in empowering and enabling capacity, we ascertained that even the poor in spite of periodic health problems can be capable water managers. For exploring capacity, three exercises were particularly useful: one to identify and rank factors that determine the "well-being" of the community, one to investigate community members' "self-confidence", and lastly, one to explore "problem solving" capacity and perceived responsibilities of individual community members with respect to those of government officials. For the "well-being" exercise, participants were asked to identify factors they deemed as relevant, visualize them by making simple drawings on cards, and then place them in order of importance. The "self-confidence" and "problem solving" exercises carried out as pocket chart voting techniques enabling distinctions to be made between the votes e.g. literate/illiterate and community members/government officials.

2.2 Summarizing WPI⁺ and comparing with WPI

The results from the explorative assessments of the five WPI components, including capacity, were summarized into a WPI⁺ jointly by researchers and community members in three main steps; choice and grouping of indicators, collecting additional data and assert values to each indicator, sub-component and component.

The choice of in the WPI⁺ (Figure 1) was based on Sullivan et al.'s (2003) list for the community scale, but indicators were added to or replaced to make it more community relevant according to local priorities and perceptions of the water situation. Consequently, several of Sullivan et al.'s (2003) indicators for community level water poverty were considered irrelevant for the WPI⁺, i.e. wealth as proxied by ownership of durable items and the percentage of households reporting water related illnesses. Instead indicators such as self-confidence, problem solving capacity and participatory assessments of health, education and social capital discussed during the workshops were included. As time restrictions prevented us from exploring health and wealth issues at depth, some WPI indicators (such as under 5 mortality) were used to illustrate these issues, but the WPI⁺ also included ownership of land and adequacy of healthcare. Indicators within each of the components were grouped into sub-components relating to major water issues giving each major water issue equal weight and reducing the sensitivity created by different number of indicators within each component. Indicators within the capacity component were thus grouped under three headings; *institutional capacity, systems for learning and health & wealth.*

Apart from the indicator data created during workshops, three more types of data were collected to allot values to the chosen indicators in the WPI⁺:

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- 1) official aggregate statistics at district level from the Madhya Pradesh Human Development Report (Government of MP, 2002), expressed in per cent (e.g. literacy rate) or number per 1000 (e.g. infant mortality);
- 2) data collected from the local rural development (Panchayat) office from 2004 and through surveys (community and targeted households) transformed into percentages describing existence and extent of different assets, e.g. households owning land; and
- 3) data created during a mixed gender workshop where community members allotted values to 15 different indicators (i.e. adequacy of education, adequacy of health care and social capital) according to: Very Bad, Bad, OK, Good or Very Good (later translated to 10, 30, 50, 70 and 90 per cent). These assessments built on information created during the process of “opening up” but also allowed the implicit incorporation of other aspects not caught in other indicators.

To enable a comparison between the WPI⁺ and the WPI, these were then calculated according to the same principles (Wilk and Jonsson, 2013). As the WPI aims to use existing data whenever possible (Sullivan and Meigh, 2007), the WPI was calculated for the community using existing quantitative data at first hand, adding qualitative data collected during the study when needed. The scale of all indicators was inverted so that higher values represented increased water prosperity.

3. Opening up the capacity component

Results from the “well-being” exercise show that a majority of identified factors determining the ability to sustain livelihoods and fulfil quality of life both at the individual and community level relate directly to the capacity component as defined in the WPI (underlined in Table 1).

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The remaining factors relate to other WPI components and are further discussed by Wilk and Jonsson, 2013. Community members perceived the sub-components *institutional capacity*, *systems for learning* and *health & wealth*, as areas of importance which also closely align to highlighted factors in natural resource management theories (see e.g. Ostrom, 1990 and Folke et al, 2005). Due to time limitations, aspects under *health & wealth* were less thoroughly addressed.

Table 1. Factors describing community “well-being” as identified by community members (women and men respectively). Underlined factors relate to capacity. The factors that are ranked are arranged in numerical order. Unranked factors are listed in alphabetical order.

SHG members (Women in Hamlet)*	WUA members (Men in Village)**
1. <u>SHGs</u>	<u>Corruption</u> (which leads to)
2. <u>Good community leadership</u>	Inadequate electricity (which leads to)
3. Sanitation	<u>Poor quality of education</u>
3. Drainage near roads	(which leads to)
4. Adequate habitations	<u>Unemployment</u> (which leads to)
5. <u>Good teachers in community school</u>	<u>Inability to afford health care</u>
6. <u>Health</u>	
7. Canal	
Identified factors not ranked: Agricultural production <u>Community culture</u> Electricity <u>Self confidence</u> Transport <u>Unemployment</u>	Identified factors not ranked: Irrigation <u>Leadership</u>
* ranking of vital factors: no 1 most important	
** (which leads to) indicates a causal relationship to the indented factors beneath it.	

Table 1. Vital factors for community “well-being” as identified by community members (women and men respectively). Underlined factors relate to capacity.

3.1 Institutional capacity

Common property resource management theory emphasise various institutional factors of the local management context such as resource dependency, common understanding, expected outcomes, trust, independency, and organizational experience. Organizational experience includes earlier successful experiences of common management, conflict resolution and local leadership (Ostrom, 1990). Well-functioning management institutions are able to deal with allocation of tasks, exchange of external resources, linkage of different types and levels of institutions, reduction of transaction costs, risk sharing and conflict resolution in order to increase the chances for the sustainable use of natural resources including water (Carlsson and Berkes, 2005). Particularly the ability of local communities to co-manage resource systems in concerted action with other types and levels of institutions has been emphasised along with social learning processes (Pahl-Wostl, 2009). This section explores the institutional capacity of the local community in terms of the emergence of local collective solutions to common problems and linkages between community-district government management institutions.

Irrigation management and micro-finance that contribute to the development of organizational experience and fostering of leadership have been externally initiated by the NGO contributing to institutional capacity in the community. However, it appears that both the WUA and the SHGs require an extended period of such support to develop sustainable institutional capacity. Before the community WUA was formed in 2005, few maintenance activities such as desilting were undertaken, conflicts between individual farmers about water access were recurrent and relations with the Irrigation Department problematic. With the formation of the WUA, these conditions were radically improved, but gradually worsened again after the NGO

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support was phased out after some years. The five SHGs, four of which are NGO-initiated, still enjoy NGO support, promoting leadership and organizational experience

Community institutions are closely intertwined with the functioning of different layers of government administration. In the “well-being” exercise, men pointed out corruption among government officials as the root factor, negatively affecting several other issues. This indicates an unsatisfactory relation between different management layers and entities, mainly between local community members, community associations and district level government officials, also repeatedly raised by community members and NGO staff. The results from the “problem solving” exercise (Table 2) reveal substantial divergences in the perceived division of responsibility between community members and government officials. Many of the problems exemplified in the exercise mirror the important factors affecting the “well-being” of the community as a whole (Table 1), particularly those related to irrigation issues.

Problem Σ Difference in perceived responsibilities (percentage points) $\Sigma_{\max} = 200$	Responsibility of individuals	Responsibility of the community	Responsibility of the government
Bad drainage in community			
% of Community members	31	22	46
% of Government officials	50	30	20
$\Sigma=53$	(19)	(8)	(26)
Defunct hand pumps			
% of Community members	47	32	21
% of Government officials	25	38	38
$\Sigma=45$	(22)	(6)	(17)
Pollution in pump area			
% of Community members	31	62	7

² Σ is calculated by adding the differences between the perceived responsibility between community members and government officials (the figures within brackets).

Σ_{\max} = if community members and government officials have completely divergent opinions on the division of responsibility for solving a particular problem, i.e. 200.

Σ **Total** is the sum of all Σ , i.e. 512.

Σ **Total**_{max} is the sum of all Σ_{\max} , i.e. 2000.

To get a figure for problem solving capacity, the actual divergence of perceived responsibilities is compared to maximum disagreement, and then converted into a percentage.

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% of Government officials $\Sigma=38$	50 (19)	50 (12)	0 (7)
Water logging near hand pumps			
% of Community members	75	23	2
% of Government officials $\Sigma=34$	60 (15)	40 (17)	0 (2)
Lack of sanitation			
% of Community members	30	51	19
% of Government officials $\Sigma=58$	60 (30)	40 (9)	0 (19)
Salinization			
% of Community members	86	8	6
% of Government officials $\Sigma=104$	40 (46)	60 (52)	0 (6)
Silt in canal			
% of Community members	43	20	37
% of Government officials $\Sigma=74$	50 (7)	50 (30)	0 (37)
Bad field channels			
% of Community members	47	29	24
% of Government officials $\Sigma=48$	50 (3)	50 (21)	0 (24)
Illegal blocking of field channels			
% of Community members	70	18	12
% of Government officials $\Sigma=44$	60 (10)	40 (22)	0 (12)
Dry canal in season			
% of Community members	14	13	73
% of Government officials $\Sigma=14$	10 (4)	10 (3)	80 (7)
Σ Total = 512 Σ Total_{max} = 2000			
Problem solving capacity (tp be inserted in Table 3) =			
$(1 - \Sigma \text{ Total} / \Sigma \text{ Total}_{\text{max}}) \times 100 = (1 - 512/2000) \times 100 = 75$			

Table 2. Perceived responsibilities for “problem solving” related to water

As shown in Table 2, certain problems regarding water access are subject to a clearer division of responsibilities (i.e. timely delivery of irrigation water from the main canal to avoid dry canals in cultivation season and the management of water logging and pollution problems) than others (i.e. salinization and lack of sanitation). Such unclear divisions of responsibilities

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are likely to hamper institutional capacity, and indicate a failure to link successfully formal and informal as well as community and local government governance institutions. Even so, the community successfully deals with certain collective concerns such as the construction of a Euro 10,000 Hanuman temple, financed by individual donations. Other pressing concerns, however, that potentially could be defined as collective, like the lack of safe sanitation, remain unaddressed by community initiatives.

3.2 Systems for learning

The “well-being” exercise identified several educational issues indicating that community members agree with academia that systems for learning constitute a vital contributor to a society’s well-being. Formal education and academic research, as well as more informal ways of producing and sharing knowledge, affect the resilience of a socio-ecological system and its capacity to adapt to various stressors (Folke, 2006, Folke et al, 2005). Moreover, the capacity for “social learning” is highlighted as a prerequisite for sustainable resource use under environmental stress (Pahl-Wostl, 2009), and for sustaining and improving livelihoods in many developing contexts (Fazey et al, 2007, Shackleton et al, 2009). Thus, the capacity for “*inventing and reinventing /knowledge/ in a meaningful order and then acting upon it*” (Folke et al. 2005) are crucial components of the management capacity of individuals as well as organizations and societies (Folke et al, 2005, Pahl-Wostl, 2009).

Community members’ perceptions of education and capacity building mainly focused on the formal educational opportunities for children as “*they are the future*”. The primary school in the community enjoys enrolment rates close to 100 % (as school meals are provided). The quality of education, however, is quite low due to the limited skills and attendance of

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teachers. Very few community families can afford to send their children to better schools in the nearby urban centres. Thus, a common judgement of community members from all economic strata was that the formal education opportunities could be substantially improved.

The systems for learning for adults in the community mainly involve capacity building in relation to the WUA and the SHGs initiated by the NGO. Adult education, organizational experience and skills, participation in training initiatives and so called “exposure” are used to foster leadership and organizational capacity. The weekly meetings of these groups, when issues of finance, conflict resolution, new crop varieties and economic possibilities among others are discussed and dealt with, create repeated adult learning situations. Though capacity strengthening efforts by the NGO are targeted at individuals, the aim is to build capacity at the community level, and also encompass various training initiatives and exposure visits. The community level WUA and SHGs are also incorporated in multi-layer organisations, i.e. clusters and a regional federation which enables comparisons of different local problems and solutions, thus strengthening inter-comparison learning.

The “self-confidence” exercise (Wilk and Jonsson, 2008) investigates the involvement of community members in activities likely to widen the perspectives of individuals for problem definitions and solutions in contexts other than the local community and to raise the ambitions for what is possible at the individual and community level. Results indicate that all were comfortable with raising their voices during meetings, but that leading a meeting and filling a formal post like chairman, secretary or treasurer, were not as self-evident for illiterate members as for literates (Wilk and Jonsson, 2008).

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With the data at hand, we can draw the conclusion that formal education, particularly for children, is highly valued by community members and that substantial opportunities for situated adult learning and capacity building are available for those belonging to targeted groups of various NGO or government programmes.

3.3 Health & wealth

Health & wealth is considered a key area by community members in determining their "well-being". It includes factors such as health, unemployment and inability to afford health care (Table 1). Similar indicators are also included in the WPI. Due to time limitations, these issues were not as deeply explored as institutional capacity and systems for learning, and included 3 only factors: Infant mortality, ownership of and adequacy of health care.

4. Summarizing co-produced findings on the capacity component

A summary of WPI⁺ is shown in Figure 1. The WPI⁺ was based on 43 indicators and the WPI on 22. While WPI and WPI⁺ index totals were similar (67 and 64) a closer look into the components, sub-components and indicators revealed major differences. The WPI⁺ contained lower values for Resources, Capacity and Environment and higher for Access and Use than the WPI.

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Figure 1. Comparing the WPI and WPI+ for a community in Vidisha Dt., Madya Pradesh, India. The main difference between the WPI and WPI+ lies not in the aggregated figures, but in the robust dialogue with local community members to integrating their assessments and priorities into the figures.

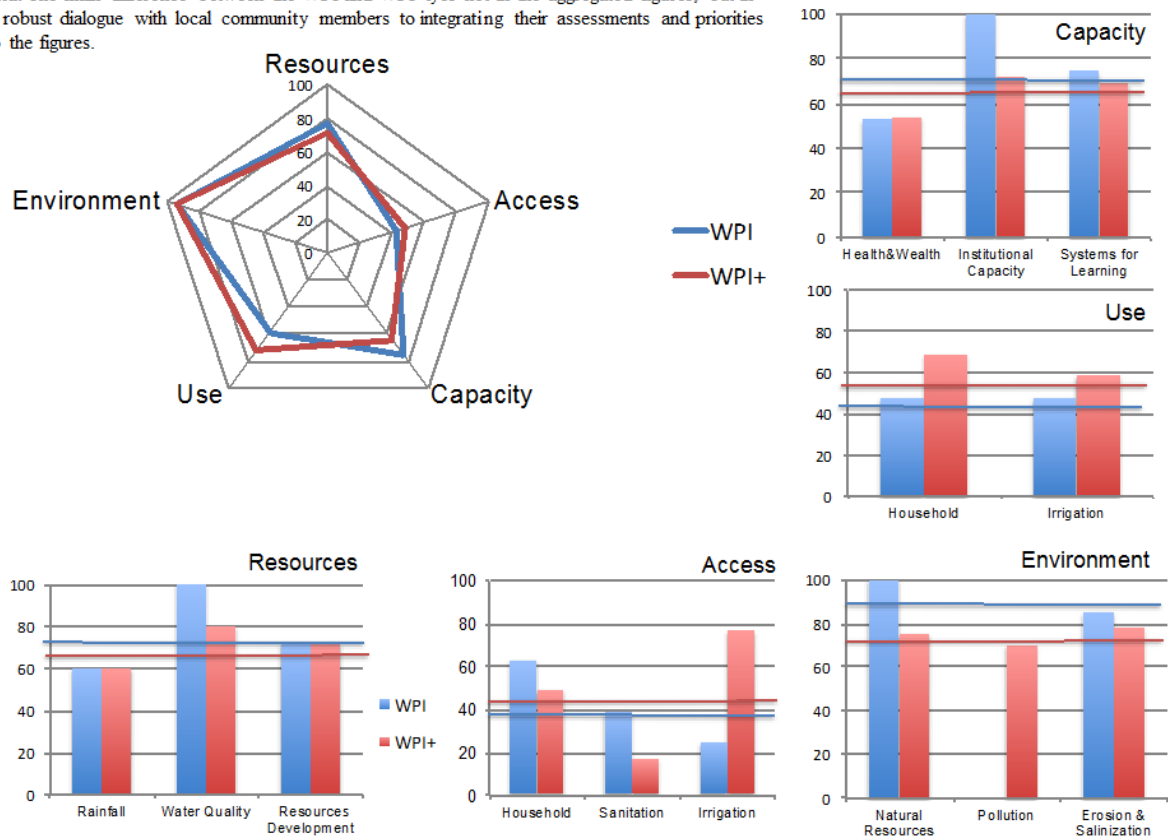


Figure 1. Comparing the WPI and WPI+ for a community in Vidisha Dt, Maya Pradesh, India.

Table 3. The capacity to manage water. Comparison between the Water Poverty Index(WPI) and the Water Prosperity Index(WPI+) for the Capacity component.		
CAPACITY Indicators	Community WPI	Community WPI+
HEALTH & WEALTH		
• Child mortality (per 1000)*	48	48
• Ownership of durable items**	58	
• Ownership of land (%)		85
• Adequacy of health care		30
AVERAGE	53	54
INSTITUTIONAL CAPACITY		
• Self-confidence (% points)		75
• Problem solving (% points)		75
• Membership in Water users associations (%)	100	100
• Membership in Self-help groups (%)		50
• Social Capital		70
AVERAGE	100	74
SYSTEMS FOR LEARNING		
• Rural literacy (%)	57	57
• Primary school enrolment (%)	92	100
• Adequacy of education		50
AVERAGE	75	69
TOTAL Capacity	76	66
<p>* Vidisha = 97/1000. Standardised. Min = 46. Max =145. Inverted. ** Average for Madhya Pradesh. The various data sources are indicated by: Red: Quantitative data for Vidisha Dt. from the Madhya Pradesh Human Development Report (2002) based on Census of India (2001) Green: Quantitative Data from the Rural Development Office (2004) updated with field surveys Blue: Qualitative (shown in italics) and Quantitative Data from Participatory exercises carried out during the co-exploration process. These include social and resource mapping, ranking and pocket chart voting exercises and qualitative assessments of water related issues over time Grey: Qualitative (shown in italics) data from a participatory assessment of 15 indicators performed at a workshop attending with male and female community members</p>		

Table 3. The capacity to manage water. Comparison between the Water Poverty Index, WPI and the Water Prosperity Index, WPI+.

The capacity component (Table 3) revealed a number of key differences in the indicators describing the capacity of the local community to manage water issues. Firstly, it is evident

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that some WPI indicators for which census data is available, indicate a considerably higher water prosperity status than local assessments (for example enrolment rate vs. adequacy of education, infant mortality vs. adequacy of health care). Secondly, institutional capacity measured by WPI indicators as the mere existence or percentage of membership in for example the local WUA may be severely misleading. Membership rates in the WUA and SHGs were 100 and 50 per cent respectively but the actual institutional capacity of these organizations was rather the opposite (i.e. the WUAs being on the decline and the SHGs being rather strong). Regarding community assessment of social capital (as an average for the entire community) and the PPA assessments of self-confidence, leadership and problem solving, these were all below 100 (Table 3). Finally, certain WPI indicators were considered irrelevant as determining their capacity by community members and were therefore omitted from the WPI⁺ (e.g. ownership of durable items not being a relevant measure of financial prosperity as even the poorest community members own televisions and cellular phones. Important items are indoor hand pumps and toilets, which were already included in the access component). Thus, even though aggregated WPI and WPI⁺ values for the capacity component appeared similar, large variations between the values of individual indicators means that the choice between them may greatly affect aggregated index values.

In the results of the WPI⁺ assessment, the engagement of the NGO in this particular community is clearly an important factor in strengthening the community's management capacity, particularly regarding certain aspects of organizational capacity and systems for learning. For example, the organisational strength of both WUAs and SHGs were to a large extent dependent on NGO support, as were aspects of adult education and training. As a consequence, the value of the aggregated capacity component is likely to be higher in this

village, than in a similar neighbouring village without NGO engagement. To highlight the importance of such external support, a specific indicator within the management capacity component reflecting the presence of an NGO and the quality of its work could potentially be included. The definition of such (set of) indicators was not considered during the co-production process, as we chose to indirectly capture this aspect in several other indicators such as self-confidence, membership indicators and social capital.

5. Conditions and results of the co-production process

A fruitful co-production process requires that boundaries between different epistemic communities are negotiated in such a way that allows different knowledge forms to be acknowledged and included in the process. The co-production process in this case built on locally anchored knowledge structured by scientific arguments, where the concept and structure of the WPI functioned as a boundary object (Levina and Vaast, 2005, Molle and Mollinga, 2003). This was possible by making the process relevant for the local context, introducing the concept *water prosperity*, rather than water poverty as point of departure and employing the NGO as a boundary spanner (Levina and Vaast, 2005, see also Folke et al, 2005). This enabled an anchoring of the process involving the local community and district government officials, and the communication of research results to national policy makers. Throughout the co-production process, NGO staff functioned as boundary spanners easing communication across both lingual and epistemic barriers encountered, even further enhanced by the employment of a community member as a co-researcher increasing the potentials for mutual understanding of alternative realities (Garnett et al 2009). Particularly, the drawing of maps and ranking exercises functioned as specific intermediary objects (Steyaert et al, 2007)

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that could help bringing together different perspectives and test different interpretations against each other. However, all boundary spanning functions were part of a gate keeping role, which undoubtedly affected the exchange and flow of information and perspectives. Participatory research, indeed, also has limitations in terms of difficulties of dealing with gate keeping tendencies and local power structures that may severely hamper co-learning and negatively affect the involvement of weaker or less organized groups (Quaghebeur et al, 2004). Although the WPI⁺ study was enabled by the cooperation with the NGO, it was not carried out in consortia with any development project, and thus did not channel any funds or assistance to the local community. Even so, issues regarding the control and manipulation of PPA techniques by various involved actors cannot be ignored. Definitely, the PPA exercises carried out “*privileged a certain type of knowledge*” (Mosse, 2005:83) that built the WPI⁺, and surely powerful villagers could interfere and use the exercises to promote their version of reality. However, to some extent this was avoided by carrying out gender-separate workshops, and by triangulating PPA outputs with other empirical sources. In this study, participation in workshops was based on membership in existing groups, i.e. the WUA and the SHGs, resulting in richer women and landless (poorer) men being considerably less represented in the co-learning process. Although we conducted household surveys and interviews to tap and include their knowledge, their perspectives were still not included to the same extent as the workshop participants.

6. Conclusions

This paper has investigated the process and results of opening up the capacity component of the Water Poverty Index at the community level. The Water Poverty Index creates opportunities to assess, understand and discuss water management issues in a holistic manner. However, such efforts always struggle with the inherent drawbacks of using quantitative

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indices (Molle and Mollinga, 2003, Mayer, 2008, Wilk and Jonsson, 2008, Wilk and Jonsson, 2013). We now proceed to draw some conclusions from the process of co-production of knowledge about the capacity component.

Firstly, the differences between the capacity to manage water described in Section 3 and the results of the WPI and the WPI⁺ in Section 4 clearly highlight the need to distinguish between the contextualized knowledge of the “real” situation and what can be described in an index. Results in Table 3 demonstrate a large variability in the values between different indicators for the same sub-component. Thus, averages and aggregations of indicators can hide significant differences, by smoothing out the extremes, hide important distributional aspects related to spatial, socio-economic and gender conditions (Wilk and Jonsson, 2013), thus oversimplifying the assessment of intricate socio-economic and institutional management strengths and weaknesses. Thus, even for scanning and diagnosing, the WPI⁺ must always be used with caution as important aspects, regional variations and vulnerable groups can easily be hidden (see also Komnenic et al, 2009, Garriga and Foguet, 2005, Molle and Mollinga, 2003). The values of sub-groups and indicators must be presented along with the aggregated values to get a truer picture of what the real water issues are and where improvements need to be made. Attention must also be given to calculating and using the WPI⁺ and collecting data to ascertain appropriate spatial, socio-economic, gender and temporal representation. We suggest that aggregated totals and pentagrams always be presented with indicator tables and/or sub-groupings. In this particular case, the main difference between the WPI and the WPI⁺ is not in the aggregate results but rather in that the WPI⁺ is based on a robust dialogue with community members where their priorities could be stressed. For this reason, any resulting interventions based on the WPI⁺ would be more “bottom-up” because of the process in which it was created. The greater number of qualitative indicators of the WPI⁺ also provides more insight into weaknesses in existing objects and services, which can better guide

remedial actions.

Secondly, while both the limitations of indices and the problems inherent in local PPAs have been highlighted in this study, we still deem the WPI⁺ to be a useful framework for working with water issues because of its holistic structure which can be used to discuss, choose, define and quantify important water-related issues. While caution must be taken to avoid subjectivity, outsider world-views and manipulation by powerful actors (Molle and Mollinga, 2003) this is equally true for all studies and with all tools. Thus, in spite of any limitations discussed in Sections 4 and 5, we argue that the WPI⁺ outcompetes the WPI for development, planning and goal setting, particularly in combination with participatory assessments of all five components; capacity, resources, access, use and environment. Such a process is far more likely to contribute to the local community's own analysis of the water situation and a formulation of locally proposed suggestions, than can be communicated to the local government by an oversimplified final index (Molle and Mollinga, 2003, Shields et al, 2002), be it the WPI or the WPI⁺.

Finally, even though climate change and capacity to adapt to its impacts were not explicitly raised in this case study, we suggest that an increased focus on the capacity component could very well be an important part in furthering the understanding of adaptive capacity to climate change.

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