A RAPID ASSESSMENT TOOL FOR INTEGRATED WATERSHED MANAGEMENT: A CASE STUDY FROM LA PLATA RIVER BASIN IN SOUTH AMERICA.

APLICACIÓN DE UNA HERRAMIENTA RÁPIDA DE EVALUACIÓN DEL MANEJO INTEGRADO DE CUENCAS: ESTUDIO DE CASO DESDE LA CUENCA DEL PLATA EN SUR AMÉRICA.

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Abstract

Environment quality indicators can be inadequate when measuring the short-term impacts of projects and actions within an integrated watershed management approach. Quantifiable changes in environmental indicators often take long periods of time –often at the decade level- and are costly in terms of data collection. The subsequent analysis and interpretation seldom reflect the outcomes of work carried out at organizational, inter-institutional and social levels in the short-term. To address this constraint, an Integrated Watershed Management (IWM) assessment methodology based on data collected through key-informants was trialed in sub basins of the *La Plata* River in South America, and compared to a similar case study carried out in Central America.

We applied the assessment tool to the mboi cae/quiteria watershed in Paraguay, and determined progress towards IWM to be 35 % (seen as a global average). We also conducted a detailed evaluation of environmental quality indicators. Comparison with the Central American case study from 2005 allowed a discussion of the methodology and its suitability in different Latin-American contexts. We propose the use of this assessment methodology, based on key-informants and data triangulation, whenever possible to obtain understanding on how projects within an IWM approach can be evaluated in a standardized manner; in a short time; and with low costs. Not substituting, our proposed rapid assessment is not a replacement for 'proper' complementary environmental assessment, but offers a rapid and preliminary appraisal of how projects or processes progress with an IWM approach, especially in rural areas.

Key words: catchment, criteria, indicators, Latin America, Paraguay

Resumen

Los indicadores de calidad ambiental pueden ser insuficientes cuando se miden los impactos obtenidos a corto plazo por proyectos o acciones derivadas de la aplicación del enfoque manejo integrado de cuencas. Los cambios cuantificables en los indicadores ambientales suelen tomar largos periodos de tiempo -a niveles de décadas- y representan altos costos de colección de datos, análisis e interpretación, pocas veces reflejando los esfuerzos realizados a niveles organizacionales, interinstitucionales o sociales en el corto plazo. Para atender esta falta de indicadores, una metodología de evaluación del manejo integrado de cuencas basada en informantes clave fue aplicada en subcuencas de la cuenca del Río de la Plata en Sur América y comparada con un estudio caso similiar llevado a cabo en Centroamérica.

Posterior a la aplicación de la herramienta de evaluación, las calificaciones fueron agrupadas e interpretadas para determinar los avances hacia un manejo integral de cuencas, obteniendo 35% (visto como un promedio global) además de un conjunto de indicadores evaluados y analizados separadamente en cuanto a su nivel de avance. La comparación con un estudio de caso realizado en el 2005 permitió la discusión de la metodología y su adaptabilidad en contextos latinoamericanos diferentes. Proponemos el uso de esta herramienta basada en informantes clave, y triangulación de datos siempre que sea posible, para obtener una comprensión de como los proyectos con el enfoque de manejo integrado de cuencas puedan ser evaluados de una manera estandarizada, en corto tiempo relativo. Sin sustituir evaluaciones ambientales "completas", nuestra herramienta de evaluación rápida ofrece un primer acercamiento de cómo los proyectos y procesos avanzan hacia un manejo integrado especialmente en cuencas rurales.

Key words: cuenca, criterios, indicadores, Latinomérica, Paraguay

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INTRODUCTION

Integrated watershed management (IWM) takes, in theory, the sector-based management and study of water to a different level; from a less technocratic to a more holistic, participative, and stakeholder-based approach (Heathcote 2009). However, complex and challenging in the face of political considerations (Blomquist et al. 2005), IWM together with Integrated Water Resources Management (IWRM) still seems to present an opportunity to reach the local potential of societies to use water in a rational and sustainable way (Saravanan et al. 2009; Jewitt 2002). The integrated and systemic vision of a watershed leads mainly to establish processes, rather than specific actions, that can lead to continuous and self-sustained work at a local level. Since the 1990’s, this integrated and participatory approach has constituted a promising approach for conserving water, land and biodiversity; whilst simultaneously enhancing local livelihoods and supporting broader sustainable development processes (Dourojeanni et al. 1987; FAO et al. 2006)

Projects in Latin America using this approach often address a wide variety of objectives, for example: inter-institutional network strengthening, establishment of watershed decision bodies, specific environmental problems (i.e. floods or landslides), establishing environmental payment schemes, technical training in production, eco-friendly production techniques, water quality monitoring, counseling in management decisions, etc. (FAO, 2006). This wide range of possibilities is explained by the approach itself which “allows” recognized interactions at the watershed level at different sub-system levels (political, social, economic, natural, political, cultural) using a systemic view of the watershed and allowing distinct interpretations, scope, aims and local concerns to be merged with agencies interests and government agendas.

Assessment methods using proper criteria and indicators to evaluate progress towards IWM seem equally challenging and have been the subject of distinct methodological proposals (Musálem-Castillejos et al. 2006a; Imbach 2006; Chaves et al 2007, Shah 2008; Biswas et al. 2012). Some methodologies can have a broad vision of processes occurring at the watershed level, for example at institution level and their networks; while other focus on families and livelihoods. The choice of the methodological approach or tool to be used should depend on the objectives of the study, the availability of information, and the time available to implement it.

The proposed methodology, based on an initial experience and presented here, mainly seeks to obtain information based on key-informants, reducing time and costs and revealing insights of IWM in a short period of time (ranging from two weeks to two months). Although lacking biophysical indicators, it allows the identification of knowledge gaps, and leaves triangulation for later stages and further funding opportunities. We propose this method as a rapid assessment tool to be applied to rural micro-watersheds, similar to what has been achieved with the Integrated Sustainability Analysis (Chaves, 2011), but with a distinct scope, and allowing for deeper studies to be carried out in further developments.

Developed for a Latin American context, our assessment tool was first trialed in Honduras, Central America (Musálem-Castillejos et al. 2006b). Application at that particular time assessed an evaluation of progress towards IWM linked to the FOCUENCAS program (a project intended to strengthen local capacities for disaster prevention and watershed management). As a second application of this assessment tool, we present the current evaluation of progress towards IWM in a priority watershed of the Yacyreta Dam in Paraguay. Our work is aimed at understanding the progress towards IWM as well as gathering experience on the performance of the assessment method in a different context inside Latin America. Our research focuses on answering two principal questions. What is the level of IWM achieved in our study area? What lessons can be learned from the application of the standard in this specific location?

METHODOLOGY

Study Area

Yacyreta dam and hydro-electricity producing facility is located in the Parana River in South America. It is a state-owned company (Yacyreta Binational Entity, YBE) administered by both Paraguay and Argentina. YBE has developed and delivered different programs regarding environmental and social issues for more than two decades. However, since 2006, it has focused on investing in programs which seek social acceptance by local stakeholders using an IWM approach in priority watersheds. We gathered information that led to the assessment of the IWM level in Mboi-cae/Quiteria river watershed, as well as the local perception by rural stakeholders of environmental and social development programs. Figure 1 shows details of hydrology, elevation, soil taxonomy and geology in the study area.

This study applied an IWM rapid assessment tool in this watershed where there have been natural resource management interventions taken through IWM in the past 5 years. In 2007 a watershed committee was formed with the support of the Environment Secretariat of Paraguay (SEAM), the financial support of the YBE, and the participation of community representatives. The Mboi-cae and Quiteria rivers, which together form the watershed of study, were impacted on a major environmental by the filling of the Yacyreta Dam in 2007 in order to reach full energy producing capacities.

The IWM assessment methodology was designed with the construction of specific criteria and indicators in rural areas. Each of the indicators is stratified into different levels or grades that can be assessed

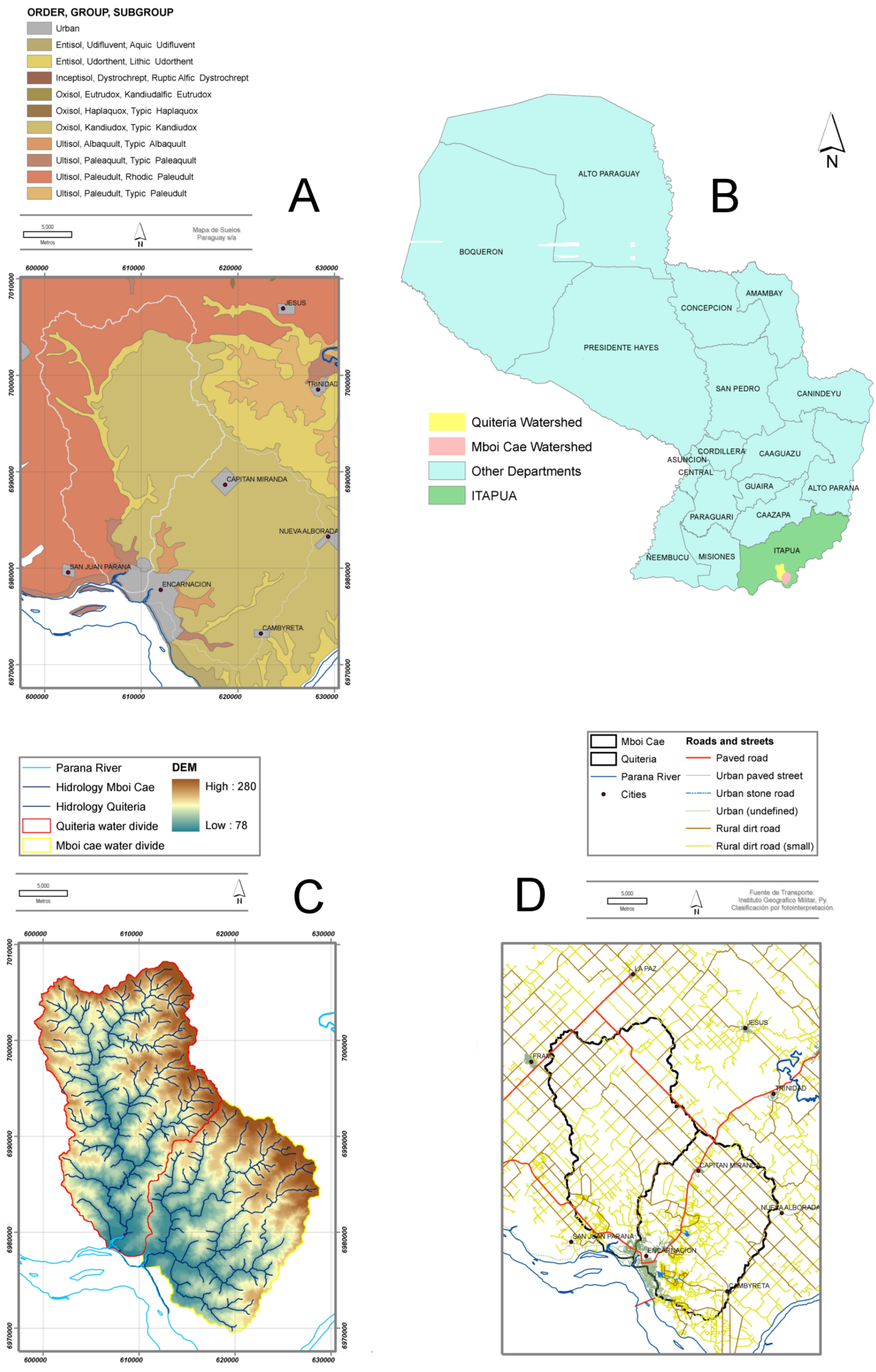

Figure 1. Maps of the Mboi cae / Quiteria watershed: A) soil taxonomy, B) location in Paraguay and Itapua Department, C) digital elevation model (masl) and rivers, and D) roads and main urban areas

by experts or key-informants combined using a snowball sampling approach (Kirby 2000). The approach provides a rapid view offering longitudinal results of the current status of integrated watershed management. Information is collected through key informants, triangulation with existing biophysical data is possible and done when available.

The IWM standard consists of 6 principles, 12 criteria, and 18 indicators (Table 1), as well as parameters for each indicator. Main steps for the application of the IWM standard are as follows:

1. Gathering information from the watershed; characterization and current state of knowledge.
2. Selection of key informants to work in one-on-one workshops where parameters and level of relevance of decision elements are thoroughly discussed and evaluated.
3. Data analysis. Consisting of summarizing different opinions on different indicators as well as results from the workshops and semi-structured interviews.
4. Interpretation of results. An output of a global assessment, as well as detailed information on each of the indicators.

Table 1. List of decision elements part of the standard used in assessing IWM for the Mboi cae /Quiteria watershed in Paraguay (Source: Musalem et al. 2006).

Decision Element	Description
Principle 1.	The watershed as a system
Criterion 1.1.	Integrated functioning and vision of the watershed
Indicator 1.1.1.	Stakeholders and Institutions level of interconnection
Indicator 1.1.2.	Level of convergence
Criterion 1.2.	High, medium and low parts of the watershed considered in the management.
Indicator 1.2.1.	Level of protection of conservation areas of the micro watershed
Principle 2.	The social-environmental and co-development angle
Criterion 2.1.	Capitalization and Investment
Indicator 2.1.1.	Level of capitalization and funding mechanisms: administration and implementation
Criterion 2.2.	Inter-institutionalism. Close relationship among public and private sectors
Indicator 2.2.1.	Level of inter-institutionalism in the micro watershed
Criterion 2.3.	Households (and their organizations) as the main objective of watershed development
Indicator 2.3.1.	Level of consideration of IWM in infrastructure programs.
Indicator 2.3.2.	Level of environmental education
Indicator 2.3.3.	Level of consideration of IWM in health centers.
Indicator 2.3.4.	Level of consideration of IWM in transportation routes
Principle 3.	Use of watersheds for planning and evaluation of impacts.
Criterion 3.1.	Use of watersheds as the planning unit for territorial development
Indicator 3.1.1	Intervention activities planned with a IWM angle.
Principle 4.	Water as the integration resource
Criterion 4.1.	Water quality as a proper watershed management result
Indicator 4.1.1.	Evidence of sediments or pollutants in water streams (inverse scale).
Indicator 4.1.2.	Presence of debris or waste in water streams (inverse scale)
Criterion 4.2.	Water quantity as a result of a good watershed management
Indicator 4.2.1.	Adequate water quantity during every season
Principle 5.	Reduction of vulnerability and risk by natural disasters
Criterion 5.1.	IWM directed to vulnerability reduction
Indicator 5.1.1.	Buffer zones next to rivers
Indicator 5.1.2.	Level of inclusion of risk assessment in watershed development plans.
Indicator 5.1.3.	Recognition of relation between natural resources management and natural disasters
Principle 6.	Production and organization units as intervention units
Criterion 6.1.	Intervention actions according to the kind of practices adopted in production units.
Indicator 6.1.1.	Use of environmental friendly technologies in productive zones within the watershed
Indicator 6.1.2	Level of adoption of conservationist production and eco-enterprises

Key informants were selected complying with the following conditions:

1. Knowledge of the area and local conditions. Persons who lived and worked in the area who have closeness to local problems, culture, social background, political conditions.
2. Familiar with integrated watershed management concepts, natural resources management in the area from government or non-governmental institutions related to natural resources policies. Scientists or University staff interested or studying in the area in relation to natural resources management, ecology, etc.
3. Decision-makers. Persons who have influence at the local level to make decisions and often represent an institution or group. Persons with a position in government, municipality, NGO's, hydro-electrical power plant managing entity, watershed council, private companies, etc.

Non-random purposive sampling allows interviewing people on the basis that they are likely to be relevant to the subject being studied. The sample reflects judgments made by the researcher that may be open to question, however, it allows the inclusion of significant individuals within the research.

Each indicator was read to eleven key-informants, the time dedicated varied from 2 to up to 5 hours with each one, depending on their level of understanding and willingness to go into deeper explanations. Two separate questions were discussed; the first aiming to tell us if the key informant found a particular indicator "important" or not, and the second aiming to evaluate the watershed's "performance" in that indicator. We used variants of the question: How important or relevant do you consider this indicator to be for the first inquiry and a straightforward question to evaluate the performance (for example: How do you qualify indicator number "x" ?)

Importance or relevance of the indicator was qualified: very low, low, intermediate, high, and very high and used as a weighted value (Table 2). On the other hand, the watershed's performance or "current status" value was obtained using a scale from zero to three (0, 1, 2, 3) where zero corresponds to the lowest performance and 3 to the highest. -i.e. the existence of a watershed council with well determined capacities, members and financing would correspond to the highest level of IWM. Intermediate values were used on occasions where some conditions were fulfilled but not all of them.

A weighted arithmetic mean, using these two values, was used to obtain qualifications per indicator, and also a global qualification (GQ) for the watershed, per informant and overall qualifications. GQ was interpreted using a discriminatory table (Table 3).

Table 2. Values of relevance for each indicator (used as a weight value).

Relevance of each indicator	Weight
Very high	5
High	4
Intermediate	3
Low	2
Very low	1

Table 3. Discriminatory table for global qualification of the watershed (GQ).

GQ in percentage	Level of reached IWM	Description
0-25	Very Low	The watershed shows none or very few actions taken with the IWM angle.
25-50	Low	The watershed shows few actions with the IWM angle.
50-75	Regular	The watershed shows some actions with the IWM angle, however it is still necessary to improve some aspects.
75 - 100	High	The watershed has many effective actions and conditions related to IWM.

A global qualification combined with the results obtained for each indicator was interpreted and arranged individually or in groups (per criteria or principle). Indicators were regrouped to visualize where the highest values were obtained, and which have lower qualifications (needing more attention). Values were also related to the initial principles considered for IWM for the watersheds of the Mboi Cae and Quiteria rivers.

RESULTS

Individual qualifications were regrouped and are presented in Tables 4 to 6. Inferiorly qualified indicators obtained the lowest values, and reflect issues that need to be addressed to move forward in the IWM process. Mboi cae / Quiteria watershed obtained most of the indicators in the lower and intermediate levels. After qualifications were reviewed separately by indicator, a key-informant overall qualification of the watershed was calculated. Global Qualification (GQ) was calculated to be 35%, after averaging individual qualifications by each of the key-informants. This value represents "still very few actions that indicate achieving a high level of integrated watershed management". Figure 2 shows GQ obtained by key-informant. Qualifications of individual indicators were grouped to their principles (according to Table 1) and graphed (Figure 3). The highest values were obtained in principles "water as the integration resource" and "use of watersheds for planning and evaluation of impacts".

Table 4. Inferiorly qualified indicators. Aspects that indicate a low performance towards achieving IWM.

Indicator	Description
2.3.2	There is a very low level of environmental education (lowest in the group)
6.1.2	A very low adoption of conservationist production techniques and eco-enterprises.
5.1.2	A very low level of inclusion of risk assessment in watershed developing plans
2.3.4	A very low level of consideration of IWM in transportation routes
1.1.1	Low level of connection between stakeholders and institutions
4.1.2	Presence of debris and waste in water streams
1.1.2	Low level of convergence
1.2.1	Low level of protection of conservation areas
5.1.1	Reduced buffer zones next ro rivers (highest qualified)

Table 5. Intermediately qualified indicators. Aspects that indicate intermediate performance locally towards achieving IWM.

Indicator	Description
2.1.1	Some capitalization and funding mechanisms
5.1.3	Some recognition of the relation between natural resources management and natural disasters
4.1.1	Some evidence of sediments and pollutants in water streams
2.3.3	Some level of consideration of IWM in health centers
3.1.1	Intervention activities sometimes consider an IWM angle
6.1.1	There are some environmental friendly techniques used in production areas, but they are not the most common
2.3.1	Intermediate level of consideration of IWM in infrastructure programs
2.2.1	Some first steps have been taken to achieve interinstitutionality in the watersheds.

Table 6. Highly qualified indicators. Aspects that indicate a good performance towards achieving IWM.

Indicator	Description
4.2.1	Adequate water quantity during every season

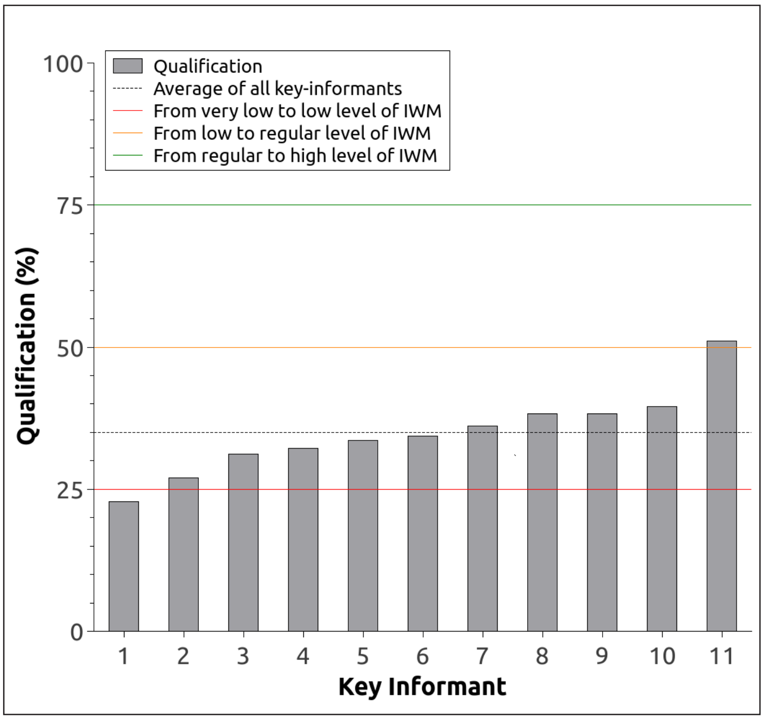

Figure 2. Evaluation of the level of IWM per key informant (sample size = 11) presented in percentage of the Mboi Cae / Quiteria watershed. Dashed line shows average (35%), continous lines (colors) show discriminatory categories of levels of integrated watershed management according to assessment methodology.

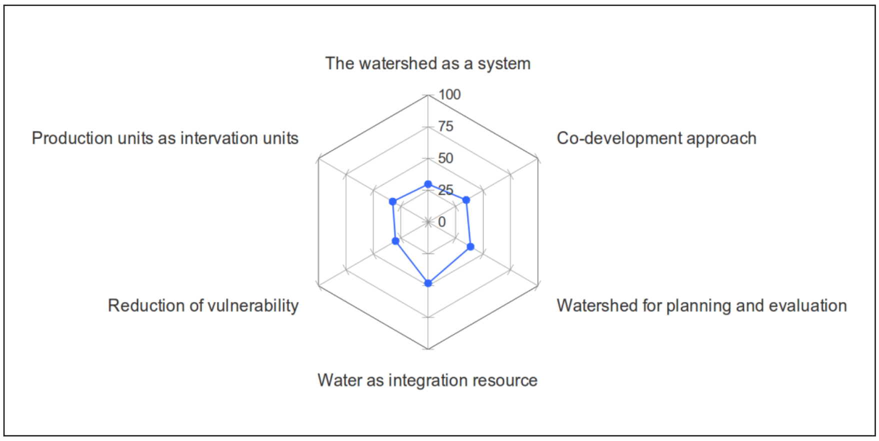

Figure 3. Qualification of each of the IWM principles, shortnames used, not full lenght principle. Values in percentage of maximum possible qualification for each of the six principles of the IWM assessment methodology.

DISCUSSION

The IWM assessment methodology allows the recognition of some of the principal characteristics of a watershed and the level of integrated management. Since it depends mostly on information given by key-informants, it is also subject to bias, depending on the experience, interests, or access to information of the informants. However, working with key-informants provides information which can be then compared to other data, such as literature review, studies, or other evidence which by triangulation helps to reduce erroneous or tendentious information. This triangulation is not always possible (i.e. when other information is not available, or when time for comparison is limited). However, an easy way to firstly analyze data given by key informants is to observe the consistency of the answers given and their similarity with the rest of the key-informants (Kirby 2000).

Compared to a previously reported application in Honduras (Musálem-Castillejos et al. 2006b), the studied watershed obtained a 35% global qualification (the Sesesmiles River watershed obtained 58%

in the previous case study), albeit there was a four year time difference in the application of the rapid assessment tool. A possibility opened by this rapid assessment tool is also to transform it into a monitoring tool, which could, after a few years indicate progress as intended by other methodologies (Imbach 2006).

Results for IWM assessment can be interpreted by indicator or by global qualification. Each indicator's final qualification can indicate how successful management is in the watershed and specify problem areas and issues. We suggest this rapid assessment tool, combined with other locally available information as appropriate as a first step, but not a substitute of further studies. A global qualification is simply the additive result of individual values obtained by the indicators and it can be misleading if not accompanied with further explanatory information.

The proposed method offers potential in its interpretation of emerging patterns; confirming or countering other studies, as well as inner consistency of data. For example, polarized responses about one subject could indicate or highlight particular misinformation or help prioritize needs for further research. Working with key-informants provides information which can be later compared to other data, such as literature review, studies, or other evidence which by triangulation helps to reduce erroneous or tendentious information. We show two comparisons to test our results obtained from key informants with other sources of information (Table 7).

Table 7. Examples of triangulation of information obtained through key-informants and other sources.

Specific topic	Key Informants response	Compared to	Results and Observations
Protection of rivers, maintance of vegetation cover along rivers. Buffer areas.	5.1.1. Reduced buffer zones next to rivers 1.2.1 Low level of protection of conservation areas.	GIS measurements show a 24-26 % riparian vegetation or vegetation cover in conservation areas according to State laws. Following methodology by Dose (2009) .	Information is compatible.
Water quality	4.1.1. Intermediate level of pollution in water streams. Some evidence of sediments and pollutants in water streams 4.1.2. Presence of debris and waste in water streams	Studies by other authors Paez (2003) confirm that water quality is unsuitable for any kind of use according to national standards (in lower areas of the watershed)	Information is not completly compatible. Differences possibly due to different perceptions depending of the specific place where key informants live.

CONCLUSION

The IWM assessment methodology involved around one month of field work succeeding in the description of some relevant characteristics of our study area; as well as an estimation of the level of integrated management achieved so far. Further case studies could help explain which are the determining factors influencing the final scores in the IWM assessment. Thus far, it has been used as a tool to understand the degree of progress towards IWM, we believe the method offers a fast but limited view of the level of IWM. The validation of this methodology is an ongoing process that still requires multiple trials and comparisons.

An unexpected outcome of the application of this methodology was that it allowed an "external observant" to become acquainted with actors connected with the IWM process occurring at that particular moment in the watershed. Interviews allowed us to obtain more qualitative information than initially intended and gave us richer insights of the watershed than can be just "read" from the indicators and the methodology itself. This can be a particular advantage for "newcomers" trying to develop comprehension of the main issues and problems concerning inhabitants of a particular rural watershed.

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