EVALUATION STUDY ON ODA WATER SUPLLY PROJECTS IN TERMS OF WATER QUALITY

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Recently, ODA evaluation is recognized as important and necessary for securing accountability and improving the quality of ODA. This study is aimed at proposing an evaluation method for ODA projects in the water supply sector in terms of water quality. Achievement Grade (AG) and Risk Level of contamination were proposed for indicators of evaluating impact as potability. To demonstrate the evaluation results, field surveys were conducted in Nepal, Philippines, Vietnam and Indonesia. In addition to water quality analysis, the following surveys were conducted for multiple understanding of the actual situation: interview with those concerned with the projects, facility study and questionnaire survey to the beneficiaries.

Keywords: *water quality indicator, water supply project, field survey, ODA evaluation, HACCP*

1. INTRODUCTION

Importance and need of ODA (Official Development Assistance) evaluation have grown for securing accountability and improving the quality ODA. Therefore, international cooperation agencies and institutes have developed their own evaluation systems. In 1991, DAC (Development Assistance Committee) called for five evaluation criteria: efficiency, effectiveness, impact, relevance and sustainability[1]. Recently, RBM (Results-Based Management) has been commonly adopted by many international cooperation agencies to share the perspectives of evaluation methods. In Japan, JICA (Japan International Cooperation Agency) and JBIC (Japan Bank for International Cooperation) adopted DAC's five evaluation criteria and the logical framework into project evaluation. However, evaluation systems that include the specific characteristics of target sectors have not been developed yet.

International cooperation in BHN (Basic Human Needs) sector is of major concern to the international community as it relates to primary goals of achieving poverty reduction and human security[2]. The water supply sector is one of the prioritized BHN sectors in ODA. For example, MDGs (Millennium Development Goals) aimed at achieving sustainable access to safe drinking water[3]. Therefore, many water supply projects have been implemented by ODA. Because of the important role of ODA in the water sector, development of an evaluation method specific to this sector is needed.

In DAC's five evaluation criteria, consideration of impact is important for the health care sector including water supply.[4] This study has two purposes. One is to establish evaluation indicators for impact, based on field surveys. Another is to demonstrate evaluation results from the established indicators. This study adopted PCM (Project Cycle Management), one of the evaluation methods that uses a logical framework called PDM (Project Design Matrix). This method was adopted by JICA in 1994.

In developing countries, water consumption is often emphasized more than water quality due to economical, technical and geographical reasons. However, water supply projects should aim at not only increasing water consumption, but also improving water quality. On the other hand, it is difficult to sustain water quality improvement achieved by water supply projects because certain technical skills and administration are required for operation and maintenance of the facilities for producing safe water constantly. In terms of health care, achievement of both water consumption and quality would bring the most effective outcomes. Impact could be measured by the following major indicators: increase of water consumption, improvement of water quality and labor for drawing water[5),6)].

In some of the cases of project evaluations, water quality is examined by data analyzed by recipient country counterparts or by subjective evaluation of users. In this case, accuracy, objectivity and availability of these examinations are questionable. Also water quality standards used are generally those developed for developed countries and not necessarily those based on the situation in developing countries.

This paper was aimed at proposing water quality indicators that reflect the problems related to water quality in the water supply sector. The paper is based on literature and field survey.

2. ISSUES AND PESPECTIVES FOR SETTING INDICATORS[7)]

2.1 Current Problems in Water Quality Evaluation

In developing countries, there are three main problems related to water quality:

(a) Undeveloped water quality standards

WHO (World Health Organization) strongly recommends that setting of standards based on its Guideline Values should be done with due consideration of regional, geological and socioeconomic situations. However, in many developing countries WHO Guideline Values are directly applied without consideration of actual conditions[8)]. Often practical standards based on actual conditions do not exist. Standards that could evaluate water quality at different achievement levels are needed for application to various actual situations.

(b) Lack of available water quality data.

Water quality data lacks due to few laboratories, technical staff and analytical skills for data. Usually, measurements by water supply organizations in recipient countries do not exist.

(c) Contamination after treatment.

Water supply systems consist of several processes from water source to the tap. There are many risks of contamination due to lack of operation and maintenance, even after the water has been treated.

2.2 PDM and Water Quality Indicators[9)]

Components of PDM on water supply project are shown in **Table 1**. Impact examines positive and negative, direct and indirect effects and is related to the Overall Goals and Project Purpose in the PDM. Mainly, these are the changes in water consumption and quality and labor for drawing water.

Table 1 Components of PDM on Water Supply Project

Narrative Summary	Examples on water supply
Overall Goal	Improvement of living-standard, Improvement of sanitary environment, Development of economic performance
Project Purpose	Safe water supply through the year
Outputs	Facility improvement, Establishment of administrative and manegerial systems, Securing engineers
Activities	Facility construction, Technical transfer
Inputs	People, Goods, Capital and Information
Important Assumptions	Policy change, Pollution or scarcity of water source

2.3 Viewpoints for Setting Indicators

Considering the current problems and definition of impact by DAC's criteria, there are 4 viewpoints for setting indicators of impact:

(a) Examining the quality of supplied water from the project by comparing the measured value with standards that have different achievement levels.

(b) Examining the quality of supplied water from the project from the users' point of view by water usage survey.

(c) Investigating whole water supply facility and domestic storage situation to cope with contamination.

(d) Using measured water quality data from field surveys by evaluators.

Based on these viewpoints, three indicators for impact were proposed: Potability, Rate of Using Project Water for Drinking and Conversion Ratio.

3. WATER QUALITY INDICATORS[7)]

3.1 Potability

(1) Achievement Grade

Quality of the supplied water from the project was examined by AG (Achievement Grade), judged by comparison of measured value and standards with different achievement levels. Japanese waterworks standards[10)], WHO Guideline Values[11)], and Sphere Project standards (applied for refugee support[12)]) were referred to. Content items of AG are shown in **Table 2**. Analysis methods of AG are shown in **Table 3**. Considering the expiration term for measurement of sampled water[10)], simplified kits and preconditioned media were adopted. For microbial aspects, film formed media was adopted because of its convenience[13)]. Though ICP (inductively coupled plasma) method is not practical for field survey in developing countries, it was adopted from the consideration of the fact that water samples for heavy metal analysis can be stored for a relatively long time and transported to a suitable laboratory for analysis.

Table 2 Achievement Grade

AG	item	remarks
A	(in addition B) Cl^-, COD, pH, Odor, Taste, Color, Turbidity, Fe, Mn, Zn, Na, Hardness	Japanese standard, monthly analysis, appropriate for service water
B	(in addition C) CN, Hg, Pb, Cr^{6+}, Cd, Se, As, F	Japanese standard, monthly analysis, related to health
C	(in addition D) Total Aerobic Bacteria	Japanese standard is applied for standard value
D	E.Coli, Total Coliform, NO_3-N, NO_2-N, Chemical	WHO guideline value is applied for standard value
E	Fecal Coliform, Total solid, Chemical Aspects*	Standards of Sphere Project
F	none	

*No significant negative health effect due to chemical or radiological contamination from short term use is detected

Table 3 Analysis Methods

item	physical aspect	chemical aspect	microbial aspect	heavy metals
term of validity	immediately	1day - 1month	1day	1month
methods	visual inspection	simple test tube	simplified, film formed media	ICP
remarks	-	-	disposal equipment, portable incubator	-

(2) Risk Level

To investigate the whole facility for the corresponding contamination, many samples and frequent measurements are needed. However, due to limitations in field surveys, it is difficult to achieve these requirements. Risk Level of contamination was therefore considered to cover these inadequacies. Risk Level examines possibilities of contamination by investigation of the facilities and is judged from the numbers of possible contamination events.

Possible contamination events were set based on the concept of HACCP (Hazard Analysis and Critical Control Point), which is often adopted in food sanitation[14]. HACCP analyzes hazards of pollution from the farm to the table concerning all ingredients and sets control points. This concept was applied to water supply by analyzing contamination events in the whole water supply process from the water source to the tap including domestic storage facilities. Hazards were grouped into four categories: chemical hazards, biological hazards, structural oriented pollution and managerial oriented pollution. This classification makes the measures against the risk easier to undertake. Contamination events are shown in **Table 4**. In total, 21 contamination events were set as evaluation items to examine Risk Level. Evaluation

Table 4 Evaluation Items for Risk Level

Facility	Evaluation Item	Applied Facility					Hazard			
		Well	Rain Water	Tap without WTP, surface water source	Tap without WTP, well source	Tap with WTP	Chemical	Biological	Structural	Managerial
water source	animals' access to source			*a)	*			*	*	
	excreta/ latrine/ waste within 10 m			*	*			*	*	
	farm, field, factories or houses in upstream			*			*	*	*	
	open/ unsealed well				*			*	*	
purification	discontinuous/ no chlorination			*	*	*	*	*		*
conveyance and distribution pipe	leakage/ illegal connection			*	*	*	*	*		*
	inadequate material, may occurred dissolution			*	*	*	*		*	
Reservoir	dirt reservoir, not cleaned			*	*	*		*		*
	unsealed/ unlocked reservoir			*	*	*		*	*	*
tap	no drainage/ doesn't work	*	*	*	*	*		*	*	
	pounding wastewater near the tap	*	*	*	*	*		*	*	*
	cracks on the concrete floor	*						*		*
	animals' access to source	*	*	*	*	*		*	*	
	excreta/ latrine/ waste within 10 m	*	*	*	*	*		*	*	
	dirt facility (spider's web etc.)	*	*	*	*	*		*		*
	unsealed facility	*	*					*	*	
	discontinuous supply			*	*	*		*		*
	seasonal change of supply, without access in dry season	*	*	*	*	*		*		*
storage, and other	dirt roof/ gutter		*					*		*
	no chlorination/without boiling in house	*	*	*	*	*		*		*
	no water quality inspection b)	*	*	*	*	*	*	*		*

a): applied evaluation items, b): groundwater system: less than once a two weeks, surfacewater system: less than once a week items were varied for each type of water supply system. This paper considers well water, rainwater and tap water, which are considered as common among water supply projects.

Risk Level was evaluated by summation of applied evaluation items. The relation between the summation of applied items and Risk Level is shown in **Table 5**.

Table 5 Judgment of Risk Level

		Risk Level			
		L1	L2	L3	L4
		Low	Intermi diate	High	Very high
Well		0-2	3-5	6-8	9-10
Rain Water		0-2	3-5	6-8	9-10
Tap (HC, PT)	without WTP	0-3	4-8	9-11	12-17
	with WTP	0-3	4-8	9-11	12-14

(3) Potability

Using AG and Risk Level jointly as indicators has the advantage of compensating for the shortcomings entailed in using the two indicators separately. Potability was evaluated between 1 and 5 as shown in the matrix in **Fig. 1**.

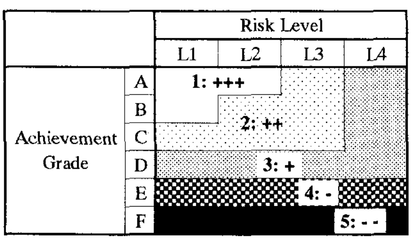

Fig.1 Potability

3.2 Rate of Using Project Water for Drinking

Water quality evaluation from user's position was examined by water usage. Generally in developing countries, many residents use several water sources, depending on the type of use[15]. The various types of sources were defined as shown in **Table 6**. They are categorized based on the assumption that when the users evaluate the water as being of good quality, they would choose that water source for drinking water. Which water of those beneficiaries use is examined as Rate of Using Project Water for Drinking (DR, %). Equations for DR are given in the following. When the household drinks water from both project source and sub source, the value of project source is reduced by one half (dr=50).

Table 6 Definition of Water Source

Source		Definition
1 Main source	Before the project	Mainly used source
	After the project	Water source implemented by the project (project source)
2 Sub source		Secondary used source
3 Sold water		Sold water expect project source (vended water, bottled Water, water from tanker truck etc.)

$$DR = \frac{dr_{A1}}{dr_{A1} + dr_{A2} + dr_{A3}} \times 100 \qquad (1)$$

Where DR: Rate of Using Project Water for Drinking,
dr: If household is using water from the source; 1
If household is not using water from the source; 0
A: After the project
1: Main source, 2: Sub source, 3: Sold water

3.3 Conversion Ratio to Project Source

To examine the improvement in drinking water quality as a result of the project, Conversion Ratio to Project Source (RC, %) was considered. RC is the ratio of water consumption from the project source (q_{A1}, L/cap/day) to the consumption before project implementation (q_B, L/cap/day). RC was calculated on the assumption that water quality for users was improved by changing to using the water from the project source. Equations for RC are shown below. These values can exceed 100%.

$$RC = \frac{q_{A1}}{q_B} \times 100 \qquad (2)$$

$$q_B = q_{B1} + q_{B2} + q_{B3} \qquad (3)$$

Where q: Water consumption per capita (L/cap/day)
A: After the project, B: Before the project
1: Main source, 2: Sub source, 3: Sold water

4. FIELD SURVEY FOR EVALUATION

To demonstrate evaluation results and examine the practicality of proposed indicators, field surveys were conducted. Outlines of the field surveys are shown in **Table 7**.

To consider versatility, field surveys were conducted in urban and rural cities in Nepal, Philippines, Vietnam and Indonesia. In addition to water quality analysis, the following surveys were conducted for multiple understanding of the actual situation: interview with those concerned with the projects, facility study, and questionnaire survey to the beneficiaries. Indicators and surveys are shown in **Table 8**.

Table7 Survey Areas and Projects[16),17),18),19),20),21)]

Country	Nepal		Philippines			Viet Nam			Indonesia	
Classification of the Area	Urban	Rural	Urban	Rural	Rural	Urban	Urban	Rural	Rural	Rural
Area Code	N1, N2	n3, n4, n5, n6	P1, P2	p3	p4, p5, p6	V1	V2	v3, v4, v5, v6,v7	i1, i2, i3, i4	i5, i6, i7
Name of the Project	The Project for the Water Supplies to Urban and Semi Urban Centers	JAKPAS Project (in Nepalese, water supply and sanitation for people)	Provincial Cities Water Supply Project I, II	The Rural Environ-mental Sanitation Project III	The First Water Supply, Sewerage, and Sanitation Sector Project	The Project for Improve-ment of Water Supply Facilities in Gia Lam Area	Hai Phong Water Supply Project,	WES (Water, Environment and Sanitation) Project	The Rural Water Supply Project in Sulawesi Island	SRCD (Sulawesi Rural Communi-ty Develop-ment Project)
Doner	JICA	WB[b)] UNDP	OECF[c)]	JICA	WB	JICA	FINNIDA[d)] WB	UNICEF[e)]	JICA	CIDA[f)]
Type of the Scheme	Grant Aid	Grant Aid	Loan	Grant Aid	Grant Aid	Grant Aid	FINNIDA: Grant Aid WB: Loan	Grant Aid	Grant Aid	Grant Aid
Period of the Project	1990-1993	1993-1996	I: 1988-1994 II: 1992-1997	1994-1998	1990-1997	1985-1994	1991-ongoing		2001-ongoing	1979-2001
Supply System[a)]	HC/ PT	PT/ HC	HC	PT	PT/ PS	HC	HC	HC/PS	HC/ PT	HC/ PT
Period of the Field Survey	March 2nd-9th, 2000		November 28th-31st, 2001 January 21st-31st, 2002			September 4th-13th, 2002 November 17th-26th, 2002 March 7th-15th, 2003			July 28th-Augest 8rd, September 3rd-18th, 2003	

a): HC: House Connection, PT: Public Tap, PS: Point Supply , b) WB: World Bank, c) OECF: The Overseas Economic Cooperation Fund, d) Finnish International Development Agency, e) UNICEF: United Nations Children's Fund, f) CIDA: Canadian International Development Agency

Table 8 Indicators and Corresponding Surveys

Indicators	Surveys
AG	Water Quality Analysis
Risk Level	Facility Study, Interview with Administrators
RC, DR	Questionnaire Survey to Beneficiary

5. RESULTS OF EVALUATION

5.1 Potability

Results of evaluation by proposed indicators were shown in **Fig.2**. The higher the score (longer bars) the lesser the potability is. Potability in all urban areas was evaluated as being in good condition. On the other hand, that of rural areas varied depending on the area. Differences among types of water supply facilities were not significant.

Hazard of contamination events by categories of pollution are shown in **Fig.3** and **Fig.4**, while **Fig.5** and **Fig.6** show the hazard by categories of source. Maximum rate of the hazard is 100% and high percentage means high risk of contamination. In rural areas with low potability, pollutions of biological and structural origin were remarkable.

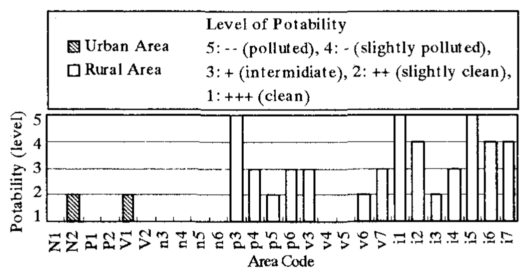

Fig.2 Potability

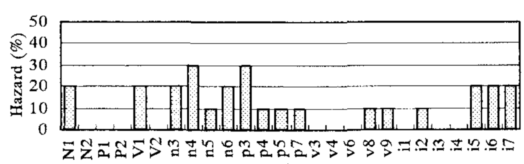

Fig.3 Hazard of Chemical Contamination

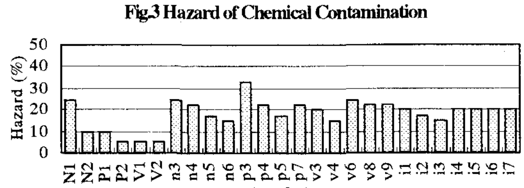

Fig.4 Hazard of Biological Contamination

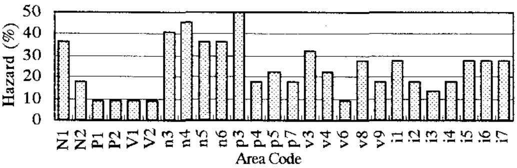

Fig.5 Hazard of Structural Origin Contamination

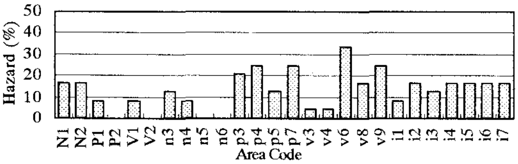

Fig.6 Hazard of Managerial Origin Contamination

5.2 Water Quality for Users

Results of DR are shown in **Fig.7**. In contrary to the high ratios in rural areas in Nepal and Philippines (n3-n6 and p3-p6), those in Vietnam and Indonesia (v7, i2, i4 and i5) showed low ratios. The ratio of using sold water after project completion is shown in **Fig.8**. In the area with low DR, residents tended to use sold water.

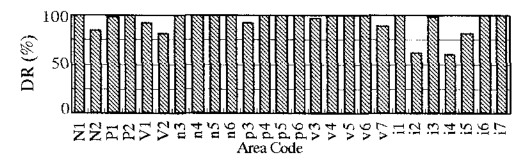

Fig.7 Rate of Using Project Water for Drinking

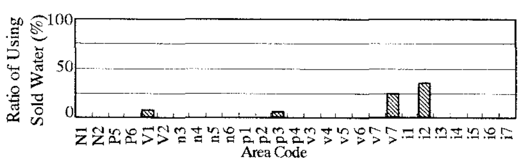

Fig.8 Ratio of Using Sold Water

5.3 Change of Water Quality

Results of RC are shown in **Fig.9**. Data were not available from the areas that were using privately owned wells or house connection without meters. The RC values for Nepal were low and significantly different from those for other countries. There were many households with RC less than 100%. On the other hand, many households in the Philippines and Indonesia had RC values of more 100%. For these areas, it was presumed that a certain level of improvement was achieved.

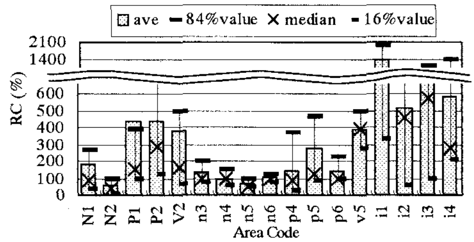

Fig.9 Conversion Rate to Project Source

6. DISCUSSION OF INDICATORS

Total evaluation was undertaken to evaluate water quality in totality and to compare results of the three indicators used in this study. The results of total evaluation are shown in **Table 9**. Some areas registered high water quality for the three indicators. Other areas registered slightly different results among the indicators. When Potability and DR showed different results (like areas p3, i1 and i2), there were gaps between measured value and users' opinions. The usefulness of objective indicators such as Potability was shown.

Table 9 Comparisons of Results among Indicators

Area	Potability			DR		RC	
Code	AG	RL	Ad.	ave.(%)	*	ave. (%)	**
N1	A	2	+++	100	+++	181	+
N2	B	1	++	85	+	54	- -
P1	B	1	+++	99	++	438	+++
P2	B	1	+++	100	+++	438	+++
V1	C	1	++	92	++	NA	NA
V2	C	1	+++	82	+	381	++
n3	C	2	+++	100	+++	134	+
n4	A	2	+++	100	+++	98	-
n5	A	2	+++	100	+++	68	- -
n6	A	2	+++	100	+++	103	+
p3	F	3	- -	92	++	NA	NA
p4	D	2	+	100	+++	139	+
p5	B	2	++	100	+++	275	++
p6	B	2	+	100	+++	144	+
v3	A	2	+	96	++	NA	NA
v4	B	2	+++	100	+++	NA	NA
v5	A	2	+++	100	+++	392	++
v6	B	2	++	100	+++	NA	NA
v7	D	2	+	90	++	NA	NA
i1	F	2	- -	100	+++	1398	+++
i2	E	2	-	62	-	519	+++
i3	B	2	++	98	++	678	+++
i4	D	2	+	60	-	585	+++
i5	F	2	- -	81	+	NA	NA
i6	E	2	-	100	+++	NA	NA
i7	E	2	-	100	+++	NA	NA

*+++: 100, ++: 90 to less than 100, +: 70 to less than 90, -: 50 to 70, - -: less than 50

**+++: more than 400, ++: 200 to less than400, +: 100 to less than 200, -: 80 to less than 100, - -: less than 80

7. CONCLUSION

In this study, water quality was evaluated by both measured value and analyzed risk. Applicability and usefulness of water quality evaluation by evaluators were shown. From the evaluation, contamination events would be specified and the results would provide useful information for the measures to prevent contamination.

Practical and objective water quality indicators were proposed. Proposed indicators were incorporated into a whole water quality evaluation system, and evaluation results in 4 countries were demonstrated. There is need for further studies to consider vulnerability of hazards for Risk Level. Moreover, the relative weight of the water quality in comparison to other indicators such as water consumption and labor for drawing water should be considered.

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水質からみたODA水道整備プロジェクトの評価に関する研究

山田淳・服部容子・佐原義規・佐伯健

近年、アカウンタビリティの確保とODAの質を向上させるためにODA評価の重要性が認識されている。本研究ではODAによって実施された水道整備プロジェクトを対象として、水質評価に焦点をあてた評価手法を提案することを目的とした。水質達成度（Achievement Grade）と水質汚染のリスクレベル（Risk Level）をインパクト評価の指標とし、飲用適合度として評価する手法を提案した。評価事例を導くためにネパール、フィリピン、ベトナム、インドネシアにて現地調査を実施した。現地調査では複合的にプロジェクトの効果を把握するために、水質調査だけでなく、関係者へのインタビュー、施設調査、裨益住民を対象としたアンケート調査を実施した。