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Sustainable Community Water Supply System with Special Reference to Nepal

Durga Prasad Dhakal[a]*, Khet Raj Dahal[b], Mukunda Neupane[c]

[a,b,c]*Lumbini International Academy of Science and Technology (LIAST), Nepal*

[a]*Email: durgadhakal2000@gmail.com*

[b]*Email: dahal.khetraj@gmail.com*

[c]*Email: mneupane2012@gmail.com*

Abstract

The study aims to find the sustainability of community water supply with reference to Nepal. The literature survey method was adopted for the study. The study found that **w**ater is an essential resource for survival and to secure good health. But people around the world are facing the problems of water scarcity. This scarcity of water forced the people to use unsafe water for the drinking and other domestic purposes. In developing countries including Nepal, 25 % of water supply projects are being defunct within two years of their construction. The major problems are related to socio-technical, management, financial, as well as community level. People's participation from planning to operation and maintenance phase is felt necessary. Similarly, the strong and capable users' committee must be formed for the sustainability of the community water supply projects. Sustainable development can be viewed as maintenance of a positive rate of improvement. Repair and rehabilitation of the systems are required to meet changing demands and conditions. Support for social capital building, active communication by local leaders with community members regarding the planning and operation of water system are important factors for the sustainable development of community water supply system. In addition to social factors, administrative, financial and technical aspects are essential for sustainable rural water supply systems to ensure the effectiveness of system over time and at reasonable cost.

Keywords: Sustainability; Community water supply system, Users' committee; participatory approach; operation & maintenance.

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* Corresponding author.

1. Introduction

Majority of community water supply systems of the developing countries are facing the problem of sustainability. Adequate clean water is essential for healthy human life, and human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights [1].

Sustainability is a process of change in which the misuse of resources, the course of projects, the direction of technological development and institutional development are all synchronized and enhance both present and future potential to meet human needs and ambitions [2]. The lifespan and the environmental aspects are related to sustainability. The first difference between various definitions referring to sustainability is the interpretation of the lifespan. For the water supply project, sustainability may be defined as the maintenance of a satisfactory level of services throughout the design life of the water supply system [3]. In Nepal, design life is 15 to 20 years. An environmental aspect is important if the supply of water has to be continued over a prolonged time. Author [4] take the environmental aspect into account in their definition: 'The water sources are not over-exploited but naturally replenished, facilities are maintained in a condition which ensures a reliable and adequate water supply, the benefits of the supply continue to be realized by all users over a prolonged period of time, and the service delivery process demonstrates a cost-effective use of resources that can be replicated'. There is strong relationship between Life Cycle Design (LCD) and sustainability of any project [5].

In Nepal sustainability in community water supply scheme means delivering service up to design life, proper mechanization of operation and maintenance, availability of spare parts, availability of maintenance personnel and active users' committee with adequate fund. This study was conducted during the period of March to May 2018 and was limited to the review of the literatures related to the community water supply systems. As the sustainability differs from case to case, it may not be generalized.

1.1 Sustainability in Water Supply System

The definition given by author [2] is considered by many as the most basic and most frequently quoted definition of sustainability. Despite several questions about these definitions, it is a durable definition because it is flexible and open to interpretation [6]. Indeed, even the definition [2] is extremely wide and relevant to different fields, later that definition is applied thoroughly to water and sanitation discipline. The Agenda 21 [7] states that "by achieving sustainable development all people, regardless of their stages of development and social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs".

Besides the definition of [2,8] define sustainability in term of infrastructure as "the design of human and industrial systems to ensure that humankind use of natural resources and cycle do not lead to diminished quality of life due to either loss in future economic opportunities or to adverse impacts on social conditions, human health, and the environment". Moreover, there are other aspects of sustainability besides these. These aspects include institutions, public participation, social awareness, capacity building, operation and maintenance, technical and financial. Smith [9] outlined that: "community water supply systems are engineered solutions that

operated through social cooperation. It has also been mentioned that the technical adequacy is the first and most critical for long- term sustainability of water system."

Another conclusion drawn on the sustainability of water supply system projects in Northeast Brazil, have recognized how ecological and community evaluation, community commitment in planning & capacity building and monitoring can assist to meet the sustainability criteria [10]. Similarly, authors [3;11;12;13], concluded in their paper that, the water supply system planned with active participation of local community are more likely to be sustainable than systems that are executed by the government or donor organizations. Community people take ownership and will be able to operate and maintain the water supply system if they actively participate in the planning stage and more likely to select supply options themselves [14].

Numerous researchers claim that water supply framework will be sustainable when users are ready to pay water charges that are adequate to bear all expenses. Willingness to pay (WTP) can be developed as a sign of the demand for enhanced facilities and their potential sustainability [15]. In contrast, author [16]; concluded that rural water supply systems are not sustainable unless grants are available to finance most or all initial construction costs.

The study found that sustainability was markedly higher in communities where household members made informed choices about whether to build a system and what type and which level of service they preferred. This relationship demonstrated factually noteworthy, even subsequent to controlling for the impacts of independent factors, for example, poverty level and distance from a noteworthy city, and project related factors, for example, training, technology, and the unit cost of the system. In spite of the fact that sustainability is higher in localities where project staff employed a demand responsive approach, the research found that there is inconsistency in the application of such approach. It is indicated by community and household surveys that some of the projects go in execution as supply driven and some of them go as demand responsive [3]. From sustainability point of view, demand responsive projects give better result.

1.2 Sustainability Aspects

From the review of different literatures, it can be concluded that following five aspects constitute the basic components of sustainability for a Community Drinking Water & Sanitation System (CDWSS). The required guidelines shall be developed by involving all of the stakeholders, using a bottom-up approach [17].

Environmental Aspect involving the required environmental assessment, maintenance of the renewable source capacity and protecting it from contamination.

Economic Aspect requiring the lowest optimized life-cycle cost, besides the project being financially self-sufficient with the agreed contributions from community members. Funds would always be available for maintenance, which must never be deferred.

Social Aspect requiring equitable access to safe drinking water inadequate quantity and of good quality, and ensuring protection of human health and social welfare.

Institutional Aspect requiring effective local community organization and management units, who are responsible for all operations and budgets and for collection of the needed funds from community members.

Technical Aspect involves conception, feasibility studies, design, construction, maintenance, operations, rehabilitation (when necessary), and finally, decommissioning and sustainable disposal at the end of its useful service life. Basically, these constitute planning, design and management of the physical infrastructure, and the technologies involved.

1.3 Chosen Definition

For the purpose of sustainability study of Community Drinking Water & Sanitation System (CDWSS), the definition of author [18] seems more appropriate. This definition takes into account all aspects required for a sustainable water system and makes the requirements more operational.

A water and sanitation service is sustainable when it is functioning and being used. It is able to deliver an appropriate level of benefits (quality, quantity, convenience, continuity, health) to all. It continues to function over a prolonged period of time. Its management is institutionalized. Its operation, maintenance, administrative and replacement costs are recovered at the local level It can be operated and maintained at local level with limited but feasible external support. It does not affect the environment negatively [18].

1.4 Water and Sanitation in Global Context

In the decade of 1970 s, in the international arena, two women, one British Economist Barbara Ward, and the other American Anthropologist Margaret Mead individually initiated the activity for drinking water supply at the United Nations (UN) Conference on Human Settlement (HABITAT) in Vancouver, 1976. They emphasized for favorable policy formulations and approvals on water supply and sanitation. The next year, the World Water Conference-Argentina, was conveyed forward with the particular suggestions so the UN made a ten-year program to center around water and sanitation. The General Assembly of UN consequently passed the determination making the International Drinking Water Supply and Sanitation Decade: 1980-1990 [19].

The 2015 update shows that there are 844 million people without an essential water facility and 2.3 billion people without an essential sanitation benefit. Among them about 159 million people still are using drinking water from unsafe sources and 892 million people using open defecation [20]. Still 842 million people of the world has no access to clean drinking [21].

1.5 Water and Sanitation in South Asian Context

Water issues in Asia are intense – 20% of the population (700 million) does not approach safe drinking water and 50% (1.8 billion individuals) needs access to fundamental sanitation [22]. The stress on water resources in Asia is rapidly intensifying with the increase in population and urbanization in the region. Climate change is expected to worsen the situation. As indicated by the Intergovernmental Panel on Climate Change (IPCC), in excess of one billion individuals in Asia are anticipated to encounter negative effects on water resources because

of environmental change by 2050. It is also projected that reduced access to fresh water will lead to a range of consequences including impaired food production, loss of livelihood security, large-scale migration within and across borders, and increased geopolitical instabilities. Drinking water in Asia is something of a success story. The population with access to improved drinking water infrastructure in 1990 was 72 % and it increased to 87% in 2006. South Asian region has a population of 1.5 billion out of the total world population of approximately 7 billion. The region has the highest incidence of poverty not only in terms of absolute numbers but also as a percentage of the population, compared to any other group of countries in the world [22].

Open defecation problem is also intense in South Asia. Still 705 million people in this region practice open defecation in rural areas and 74 million do that in urban areas [7]. Therefore, enhancing sanitation scope with access to safe drinking water is of exceptionally significance for the improvement and ensures to accomplish the Millennium Development Goal (target 7 C). The quality and status of water supply in the ground reality as indicated above will influence the sustainability in the water supply system.

1.6 Water and Sanitation in Nepal

Among various components of sustainability, ensuring source sustainability is an important component of Community Water Resource Management (CWRM). Water systems have a limited design life, and technical failure may occur without the viability of the source itself being compromised. A more serious, and less understood threat to sustainability, is how broader processes occurring within the watershed impact upon the source itself, independent of technical failure. While the former can be addressed through design and improved monitoring, the latter requires engagement of broad-scale issues of change in the environment, the climate, and land use. Given the vulnerability of sources to natural and technical failure, protection and diversification are essential. Source sustainability can be improved by proper Assessments of Environmental Change, Appropriate Infrastructure to conserve and Sustain Water, Multiple Use Water Systems, Rainwater Harvesting, Fog water Harvesting and Ground Water Recharge Poll. Technology, people and institution are the main three factors of water supply system, which determines whether the scheme is sustainable or not [23].

Nepal has history of about 40 years of community management experience. In the rural village, weak institutional capacity is the main obstacle for sustainability of drinking water system. Most of the Rural Water Supply Schemes have been affected by several water contaminants like E. coli which decreased the life of projects sustainability [24].

According to government policy of Nepal, operation and maintenance costs of the projects should be financed by community itself while the investment cost is covered by the donor agencies or the government [25]. Community may also contribute to project investment by providing labor, land and local materials. Water prices and the necessary resources required to come from consumers governs the future of sustainability of drinking water projects [26,27]. Water User Committee plays a vital role in the sustainability of rural water supply schemes [28].

The data of National Management Information Project (NMIP) [29] reveal that there has been a significant

acceleration in sanitation progress both in terms of access to improved sanitation and, very importantly, a substantial decrease in open defecation. Still a good way to go, to ensure sustainability, move towards total sanitation, and take care of fecal sludge in urban areas. Though it is in improving trend, embedding good hygiene behavior will take time.

The sustainability of drinking water systems is a priority concern for the sector. The underlying causes of the low rates of functionality can be attributed in part to inadequate management of operation and maintenance. It is reported that around one third of the community water supply schemes have a Water Supply and Sanitation Technician to take care of the scheme, almost same number of the schemes only have registered Water and Sanitation Users Committees, and less than 5% of the schemes have an Operation & Maintenance fund [30].

1.6.1 Water Governance in Nepal

Until the 1970s the rural water supply and other community development was mostly in the hands of community members themselves. The establishment of the Department of Water Supply and Sewerage (DWSS) under the Ministry of Water Resources in 1972 boosted the development of centrally organized water supply services in Nepal. DWSS was the main actor in the sector throughout the 1970s when the water supply development still concentrated on urban areas and district headquarters. Since the 1970s the construction of small-scale village-level water supply schemes was the responsibility of the then Ministry of Panchayat and Local Development (MPLD). However, although some rural water supply development took place in 1970s the water supply sector remained rather undeveloped main activities concentrating on urban centers [31,32].

During the 1980s, partly due to the pressure by United Nation's International Drinking Water Supply and Sanitation Decade, the water sector started to gradually open up for NGOs and bilateral and multilateral donors who started to implement water supply schemes also in the rural areas. Some of the major actors included UNICEF, United Mission to Nepal (UMN), the World Bank, the Swiss NGO Helvetas and Asian Development Bank (ADB). In the 1990s as a part of the poverty reduction strategy water sector became one of the priority sectors of government investments. As a result, increased amount of rural water supply projects led by private sector and NGOs started to emerge and the focus increasingly shifted to community-based projects as decentralization policies started to take root in Nepal. The Ministry of Panchayat and Local Development (MPLD) was succeeded by the Ministry of Local Development (MLD) under which the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) was established in 1997. DOLIDAR then took responsibility for the implementation of small-scale rural water supply projects in coordination with local communities. The Department of Water Supply and Sewerage (DWSS), shifted under the Ministry of Housing and Physical Planning (MHPP) was still responsible of the larger projects [31,32].

Water issues are stretched over various ministries, while key ministries involved with the water sector at the central level are Ministry of Urban Development (MUD), Ministry of Federal Affairs and Local Development (MOFALD), Ministry of Finance, Ministry of Health and Population, and Ministry of Education. The coordination of water supply and sanitation efforts falls mainly under two agencies: a) Department of Water Supply and Sewerage (DWSS) under the Ministry of Urban Development and b) Department of Local

Infrastructure Development and Agricultural Roads (DoLIDAR) under the Ministry of Federal Affairs and Local Development (MOFALD). At district level DWSS is represented by Water Supply and Sanitation Division Offices (WSSDO) while DOLIDAR is represented through District Technical Offices (DTO), which is responsible of the technical issues [33]. After restructuring the ministries of Nepal in 2018, Department of Water Supply & Sewerage falls under the Ministry of Water Supply.

At present water and sanitation sector in Nepal is characterized by institutional fragmentation, lack of coordination and presence of overlapping roles and responsibilities among different levels of governance and agencies [31], [33]. The plan for the Department of Water Supply and Sanitation (DWSS) to phase out from direct implementation of rural water supply and sanitation schemes to hand over the ownership and responsibility for the operation and maintenance to local bodies was set over fourteen years ago in National Water Supply and Sanitation Strategy 2004. In practice this development has not taken place and the duplication of roles and activities between different ministries had led to a circumstance of institutional fluffiness in the sector [31]. However, challenges with institutional weakness and lack of coordination have been acknowledged also nationally and some actions have been taken to harmonize the water sector. Those have included preparation of National Sanitation and Hygiene Master Plan and establishment of water supply, sanitation and hygiene (WASH) coordination committees at different levels of society. Sector Efficiency Improvement Unit (SEIU) of the Ministry of Urban Development has organized Join Sector Reviews in 2011 and 2014 to bring together key players in water and sanitation sector from INGOs to government offices to discuss burning issues in the development of the sector [34].

Overall coordination and information sharing of the water supply and sanitation activities at the district level falls on the District Water Supply and Sanitation Coordination Committee (DWASHCC) which provides a platform for linkage between different agencies. Due to the vast number of actors in the sector, coordination is vital. All executing agencies expecting to do water supply and sanitation project interventions in the district are required to introduce themselves at DWASHCC and abide by the local planning process. While the Local Development Officer of DDC chairs the meetings the division chief of the WSSDO works as the secretariat. Various NGOs and private sector agents as well as other relevant government agencies are also represented in the committee. In theory, a Village Water Supply and Sanitation Coordination Committee (VWASHCC), a structure similar to DWASHCC at district level should be present in each VDC to coordinate the actors in the community level. However, the actual implementation of the committees is still lacking or the committees are often weak [33,35].

1.6.2 Water Users Committees

Water Resources Act 1992 and its regulations constitute the main legislation in Nepal which covers the use of water and water source management. The Act states that people interested to use the water resource can establish a user's committee for collective benefit of all the users on an institutional basis. In order to be acknowledged as a legal entity, the committee needs to have a constitution and register itself at the District Water Resource Committee (DWRC) within the district it is located in. DWRC is a body with representatives from all district offices engaged in issues related to water resources. The Act further defines that water user's

committees shall be continuous as well as autonomous organizations with self-governance having the right to get, utilize and offer property, have a separate seal for the work, and have the right to appeal as a person which may also sue or be sued against. While the roles and responsibilities of user's committees have been defined in the Water Resource Act 1992 and its Drinking Water Regulation 1998, Rural Water Supply and Sanitation Policy and Strategy 2004 also define some guidelines for the committees stating that the lead role in constructing and implementing as well for the operation and maintenance (O&M) of rural water supply projects is on communities and user's committees [35].

The Federation of Drinking Water and Sanitation Users Nepal (FEDWASUN), established in 2004, is an umbrella organization for water and sanitation user's committees in Nepal. It advocates water and sanitation rights at a national level and operates also at district level with an aim to increase the cooperation and good governance among the user committees and service providers. The organization directly represents the water user's committees [36].

As indicated by [37), the, local government bodies at the village and district level shouldn't directly execute water supply & sanitation projects but rather their part is to facilitate with implementation as well as regulation and monitoring of the projects. It states that VDCs will have to lead for the involvement of users' committees in the construction of community water supply and sanitation facilities and to contribute in the form of cash and kind. However, the lack of clear understanding on the facilitating roles of different agencies especially between District Technical Office (DTO) and Water Supply and Sanitation Division Office (WSSDO) has resulted ineffective implementation of the policy. Although there have been attempts by some actors to engage VDCs in the monitoring, regulating and facilitating projects the engaging is still lagging behind from the level envisaged in the policy. It can be assumed that this is partly due to the challenges with local administrative systems and lack of elected representatives for long time [38].

1.7 Sustainability Attributes

Author [39] noted that misdirection in developing a definition for sustainability was due to the differences in opinion on expectation of what will last, and of accomplishing accord on what we need to last In addition, the failure to account for "the range of interrelated time and space scales over which the concept must apply", which creates further difficulties in development of a clear definition. They concluded that sustainability cannot be maintenance forever as all systems have limited longevity. If system sustainability was supposed to have an infinite life span, nothing would be sustainable. Rather, a system is sustainable if it "attains its full expected life span within the nested hierarchy of systems (a meta-system) within which it is embedded" [39]. They provided the example of an individual human being considered sustainable in the earth meta-system, if he/she achieves normal life span. Factors causing a reduction in normal life span of a system component reduce sustainability of the system; for the human example, these factors could include various life-threatening diseases. A system can be considered to be sustainable if "it persists in nominal behavioral state" for a time equal to or more than its normal natural expected life, keeping in mind that the life span of a component can be different from that of the system. Therefore, sustainability cannot mean existence, continuation, or maintenance of each and every component of a system, or a sub-system for ever. The Author [17] noted that "the word sustainability implies

continuance or maintenance", whereas development implies change. Therefore, sustainable development "can be viewed as maintenance of a positive rate of improvement." Again, "improvement involves change"; therefore, this provides an important base to understand that "continued existence (of something) is not a necessary condition for sustainable development". Periodic modifications of the systems are required to meet changing demands and conditions.

Any action to fulfill the demands at a given time by making improvements in any component or sub-system of an overall system should be considered a pro-sustainability action as long as it does not impair the environment and the capacity of the coming generations to meet their needs [17].

1.8 Water Quality

The polluted drinking water is responsible for large number of mortalities and morbidities due to the water borne diseases like typhoid, cholera and helminthic infection [40, 41]. Safe drinking water reduces child mortality. Potable water should meet the standards of quality in terms of bacteriological and chemical pollutants. These standards are often governed by national governments; international recommendations can be found from the World Health Organization [40].In case of any adverse effect to public health due to the use of water, the scheme will not be sustainable. Drinking water quality is subject to extensive quality standards, regulating the Maximum Allowable Level of Contaminants (MLCs) or Maximum Concentration Level (MCL). Public attitude and impact of different parameters are different for different countries because of local differences in the quality of water. Author [39] has define drinking water as "if and only if no any significant health risks during its lifespan of the scheme and when it is consumed". In term of drinking water quality, user perception is one of the most important things [41]. Physical parameters like electric conductivity (EC), hardness, PH, color, odor and turbidity is not concern with human health but it should be ensuring to user acceptability. However, these parameters are function as indicators of other contaminants [40]. Alkalinity of water measured in PH is crucial for several chemical and biological processes. Knowing the pH of water, it is possible to predict the ironic form in which a substance is present and which chemical reactions that will occur. PH has no direct impact on consumers. According to Publisher [40], low PH level can create corrosion resulting in contamination of drinking water and create bad taste and appearance. Electrical conductivity (EC) measures the electric current that can be passed through the water, a function of number of ions in solution. High conductivity indicates the presence of inorganic substances, such as an aluminum, calcium, chloride, iron, nitrate, phosphate, sodium and sulfate.

Microbial Assessment:

A health risks associated with drinking water are infectious diseases, caused by water contamination by bacteria from human or animal feces [39]. Microbiological testing of water is commonly done by using total coli form or E. coli as indicator species. Both are found in the intestine and feces of warm blooded animals. According to Government of Nepal the "Water Supplier" are responsible for water quality monitoring. Nepal also has set standards & directives for monitoring the rural and urban water supply systems [42].

2. Conclusion

The country like Nepal needs sustainable development as it has no adequate funds to build new projects repeatedly. There are many reasons of project failure in Nepal. The major problems are related to socio-technical, management, financial, as well as political ones. Launching the supply driven project instead of demand driven, ignoring the active users' participation and lack of institutional capacity are driving the community-based water supply projects towards failure.

3. Recommendations

For the sustainability of the community water supply systems, people's participation from the beginning to the post construction phase is necessary. Sufficient operation & maintenance fund should be allocated. Formulation and implementation of water safety plan is mandatory. Similarly, the strong and capable users' committee must be formed and institutional capacity building is necessary for the stakeholders.

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