Bibliometric Perspectives on Sustainable Financing for operation and maintenance of Rural Water Scheme

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Abstract: *This paper conducts a bibliometric analysis of sustainable financing for the operation and maintenance of rural water schemes. Recognizing the complexities inherent in financial management of such schemes—encompassing social, economic, technical, and environmental factors—the study analyzes the existing body of literature to map research trends and identify gaps. The study employs bibliographic coupling to review 409 relevant contributions retrieved from Scopus database, with a focus on sustainability, community management, and technical challenges. Six key thematic clusters emerged, highlighting issues such as demand-driven community management, operation and maintenance financing, and socio-ecological impacts. The analysis provides insights into the evolving understanding of rural water schemes and suggests the need for better integration of institutional, environmental, and financial strategies to enhance long-term sustainability in context of climate change. Recommendations include shifting from isolated schemes to networked systems and fostering stronger external support mechanisms to overcome operational challenges.*

Keywords: *Bibliometric Review, Operation and Maintenance, Rural Water Schemes*

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Introduction

Financial management of Rural water scheme is a complex subject that touches upon several disciplines encompassing- philosophy, economics, management, politics, health, engineering, geography, culture and social science. Because of its overarching feature, it is difficult to isolate a particular area that can best explain its intricacies. In general it has been found that financing sustainable rural water scheme is difficult because of following

i. Limited financial resources: It can be challenging to finance water projects in rural areas since these communities frequently have limited access to financial resources like grants and loans (Lockwood, 2019).
ii. Large upfront costs: The initial expenditure for constructing the rural water scheme is very high, presenting another hurdle to project implementation as the communities have limited financial resources. (Evans et al., 2012; Samra et al., 2011).
iii. Difficulty in generating revenue: Most of the rural water schemes are not market based and due to the fact that many rural populations may not have the financial means to pay for water services, it can occasionally be challenging for rural water systems to generate enough income through user fees (Prokopy, 2005).
iv. Limited technical expertise: Rural communities lack proper technical expertise needed to design and implement water schemes, which eventually leads to rise in the cost and complexity of the project (Chukwuma, 2016).
v. Political and social challenges: Rural water schemes in general can face political and social challenges, which includes land disputes, community resistance and cultural barriers. As a result it is often difficult to get projects approved and implemented (Gunda et al., 2019)
vi. Maintenance and repair costs: Rural water schemes once complete generally have uphill task in have ongoing maintenance and repair costs that can be a burden on communities with limited financial resources (Hope et al., 2020)

Based on these preliminary considerations this paper attempts to reflect on various nuances of extant scientific knowledge pertaining to "Rural water financing". In this regard a detailed domain-based Bibliometric review is proposed that can unpack the detailed entangled intricacies inherent in the area. The purpose of which is to systematize and consolidate the knowledge and determine the possible research gaps that exist in the domain of rural water financing. Following section explains the methodology applied for Bibliometric review along with the research protocol applied to carry out the process. The third section presents the major findings and extricates the concurrent themes which are critically analyzed. A critical discussion of the study results follows, which paves the way for the concluding section, where the main implications obtained from the literature review are argued.

Methodology

This paper attempts to draw attention in understanding the evolution and trajectories in the academic domain of sustainable financing of rural water schemes. For this purpose a text mining tool of Bibliometric analysis has been adopted as a method of choice. Mainly it helps in unpacking the various nuances pertaining to the evolution of knowledge in a particular field and at the same time provides a projection towards the emergent areas in the domain (Donthu et al., 2021). Thus it provides a way to obtain an overview of the domain along with identifying the gaps in the knowledge and help derive better ideas for future contributions. Bibliometric review was chosen over Systematic Review and Meta-Analysis as it can analyzes voluminous literature more than 1000 papers at same time and also handle both qualitative and quantitative date (Linnenluecke et al., 2020; Donthu et al., 2021). Further, from among several available Bibliometric review techniques, the Bibliographic Coupling, that connects two independent paper sharing common literature is chosen as it allows developing both retrospective and prospective perspective of the domain. As detailed below, the study protocol consisted of three steps. It started with an inclusive search of relevant items to be included in the literature review (*data collection*). Next, the inclusion and exclusion procedure for choosing impactful pieces of information was crafted and implemented (*data cleaning*). Finally, the *core analysis* was realized, which included both the cluster analysis based on Bibliographic Coupling and the interpretive review adhering to the guidelines recommended by Tranfield *et al*. (2003)

Data Collection

Data collection started with a preliminary search aimed at generating a representative list of key terms fine-tuned to the study purpose. After a number of trials, the most relevant terms to attain the largest range of concepts related to the rural water schemes was identified. For the purpose of data collection, Scopus® index was chosen as it provides a broad array of high ranked publications and further it screens out all the predatory journals. The identified key terms were executed through a Boolean search query on January 13th, 2024. The search string follows:

TITLE-ABS-KEY ("rural water" AND ("Finance" OR "Sustainability" OR "Operation and Maintenance"))

Data Cleaning

The data cleaning started by using cursory descriptive analysis of the master search file retrieved from SCOPUS Index database. The retrieved contributions were then pruned using two main exclusion criteria: 1) no direct relationship with the study purpose (*i.e.,* contributions which did not deal with rural water financing); 2) Documents that don't have relevant meta-data such as authors name. As a result of the screening activities, the authors unanimously approved to exclude 43 documents.

Specifically, 12 documents were dropped as it didn't have any name of the author, 30 documents meanwhile were considered as out of scope as it dealt with more technical aspects such as engineering and health. For instance a very highly cited paper (Adamowski & Chan, 2011) was not included in analysis as it dealt with algorithms involving artificial neural networks in forecasting of groundwater. In the last assessment, 1 book was also dropped as it was more related to the overall case study method of qualitative research. The finalized dataset encompassed a total 409.pertinent and impactful contributions in rural water financing.

Results

Core Analysis

The core analysis was carried out using the VOS viewer (*vers. 1.6.10*) a standard Bibliometric analysis tool (van Eck & Waltman, 2010).Following specific criteria were used for analysis

i. Paper needs to have at least 10 citations in SCOPUS ranked journals. This is done to make sure the paper are indeed contributory to the domain

ii. Use of Full counting method as advised by Aksnes et al., (2012) .

Applying these two limitations total 105 papers with six main clusters were identified. The clusters visualization is shown in Figure 1

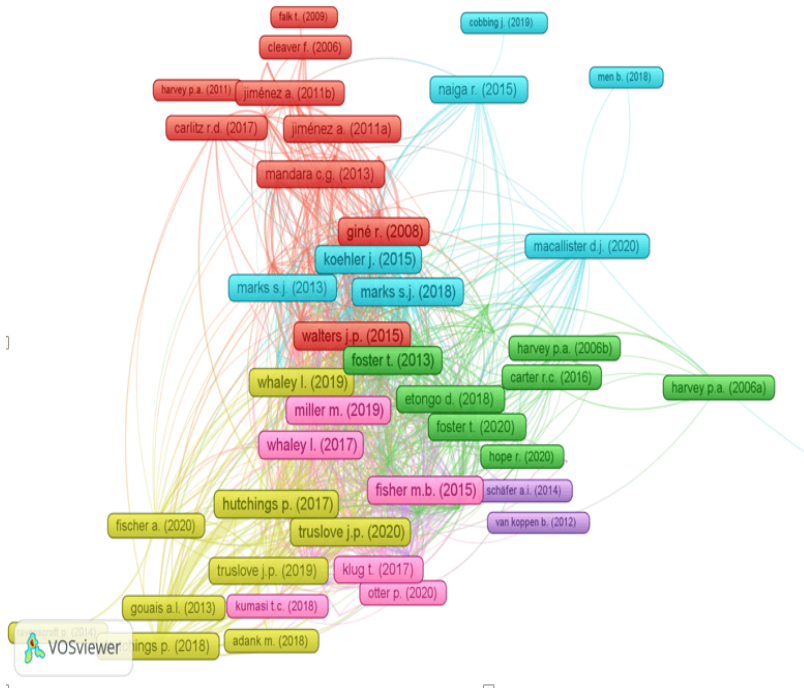

Figure 1. Figure 1 Main Analysis Cluster

Descriptive Analysis

Main core analysis was followed by descriptive and temporal of the retrieved papers . Based on the 105 papers selected, the temporal movement shows that rural water financing with respect to sustainability, operation and maintenance evolved from and has gained much attention since 2010. The time progression is shown in figure 2

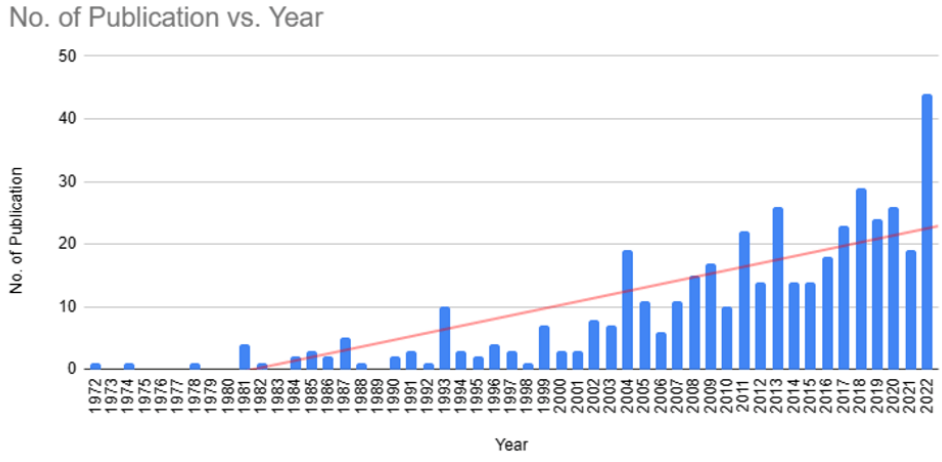

Figure 2: *Publication of the papers related to rural water financing over the years*

Meanwhile country wise analysis shows that most of the research pertains to Sub-Saharan Africa, followed by Latin America and South East Asia. Also one paper related to Nepal made the final list of analysis. In terms of origin of publications there are journals from a total 88 countries that dealt with the discipline. Among them most of the publications are from the United Kingdom followed by the United States and India. The countries with top 5 publications are shown in table 1 below while distribution of published cited papers across the globe is shown in figure 3

Country	Documents	Citations
United Kingdom	89	1938
United States	83	1274
India	32	91
Australia	28	510
South Africa	24	321

Figure 2. Table 1Countries with Highest cited paper

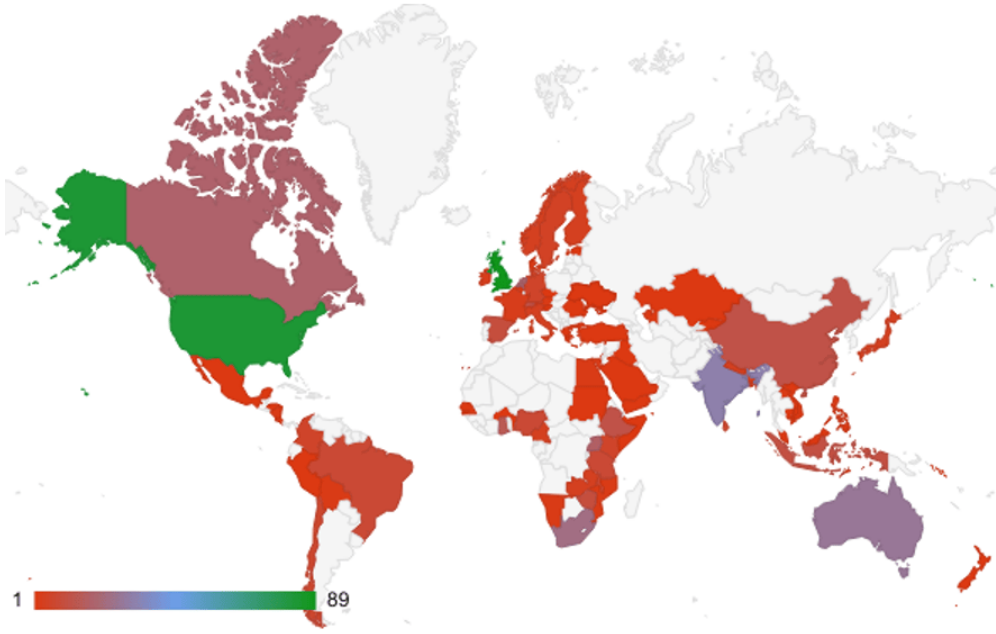

Figure 3. Figure 3 Distribution of cited paper on rural water financing across globe

On the other hand based on the descriptive details of six clusters identified through core analysis are provided in table 2

Clusters .	**Main Theme**	**No. of Papers**	**Oldest Publication Year**	**Latest Publication Year**
Red	Community Based Management of Rural Water Scheme Using Demand Driven Approach	28	2004	2017
Green	Nature and Challenges in Operation and Maintenance of Rural Water Scheme	19	2006	2020

Pink	Factors that influence functionality and sustainability of rural water schemes	17	2014	2020
Yellow	Role of planning in rural water schemes	16	1993	2020
Purple	Socio-Ecological factors disrupting rural water schemes	14	1996	2019
Blue	Need of Institutional ownership and property right reform of rural water schemes	13	2002	2020

Figure 4. Table 2 Description of identified six clusters

Main Findings

The Red Cluster: Community Based Management of Rural Water Schemes through demand driven approach

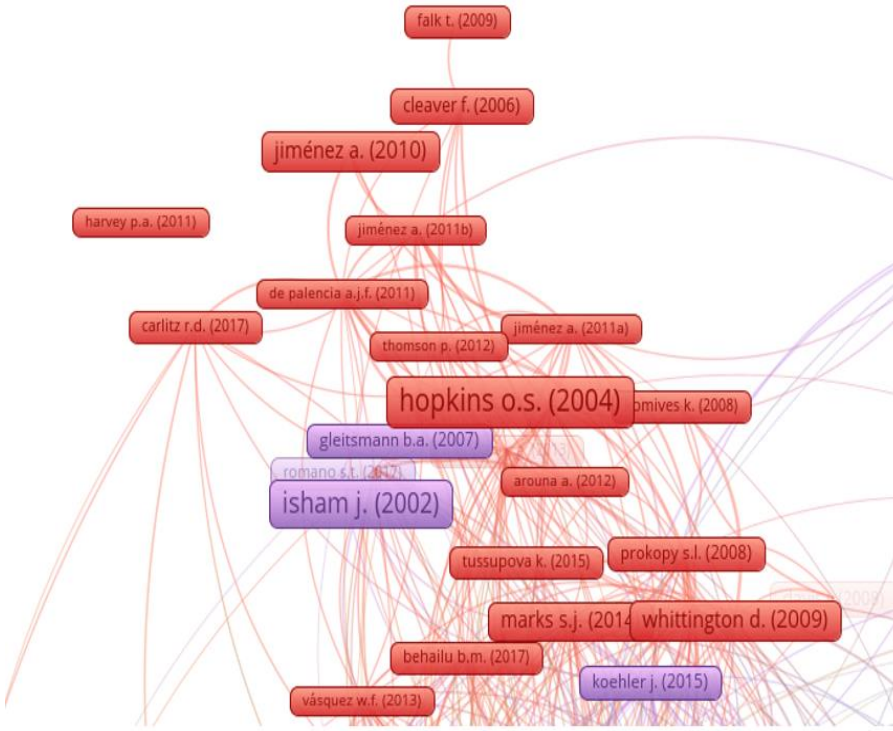

Figure 5. Figure 4 Red Cluster Network

The red cluster comprises a total of 28 papers published from 2004 till 2017. The main theme emerging from the red cluster concerns the community based management of rural water schemes through demand driven approach. The review indicates that the community based management of rural water schemes emerged as a way to answer the concern of self-sufficiency raised by stakeholders including government and international funding agencies (Hopkins et al., 2004) . As a result of which the previously applied model of supply side management of schemes where government and donor agencies dominated the planning, operation and maintenance was abandoned in favor of involvement from the demand side that constitutes community users. This development was in alignment with (Black, 1998) according to which the 20 years of learning spanning from 1978 to 1998 showed that the top down approach of designing the water supply scheme in developing countries failed because of lack of user participation.

In fact this approach of managing the rural water schemes through community participation has translated to a wide array of success across South America and Africa. Studies done in Ghana, Peru and Bolivia have shown that above 90% of community managed rural water schemes are functional indicating that this model is the best way to design and implement water systems in developing countries(Whittington et al., 2009).One of the most clear cut pictures is identifying the demand of the community which can be easily undertaken using the standard assessment of willingness to pay using the popular contingent valuation method. Study carried out in Kazakasthan Indicates that assurance of quality and continuous supply is the main driving factor that pushes the willingness to pay upward (Tussupova et al., 2015)

However this simplistic notion of addressing demand driven approach using contingent valuation method is not enough as community participation in itself is a complex process and is very difficult to identify whether it can be addressed through cost sharing or community ownership. As shown in ethnographic study by (Cleaver & Toner, 08/2006) in Tanzania, the issue of cost sharing and community ownership in general is muddled by the lack of micro level institutions, existence of structural inequalities, elite capturing the local development, thus resulting in efficiency and equity tension. In fact a broad literature review has identified up to 101 feedback mechanism through interaction of various factors ranging from technical,social, financial, institutional and environmental; complicating the community based rural water scheme and their sustainability(Walters & Javernick-Will, 2015) . Similarly a study using causal loop analysis done in Timor-Lesete also highlighted the limited operational and technological capacity of community managed schemes resulting in greater inefficiencies(Neely & Walters, 2016).

Another study showed that the depth of community participation,such as amount of cash or labor contributed, and the number of meetings attended for planning, in fact is positively correlated with the sustainability of community managed handpumps. But at the same time the breadth of participation measured by the share of households involved in particular planning or construction activity had a negative effect (Marks et al., 09/2014). This study done in 200 households in Ghana, thus shows that the community is good in handling the overall managerial decision but when it comes to technical decisions they are very much compromised. Meanwhile the most recent paper in the cluster indicates that though community managed schemes are ideal to address the rural demand they are inadequate because any reform is undermined by the lack of due democratic process(Carlitz, 05/2017). Furthermore, with money channeling from the government is based on political favoritism, the situation is more complicated by local politics.

The Green Cluster: Nature and challenges of Operation and Maintenance of Rural Water Scheme

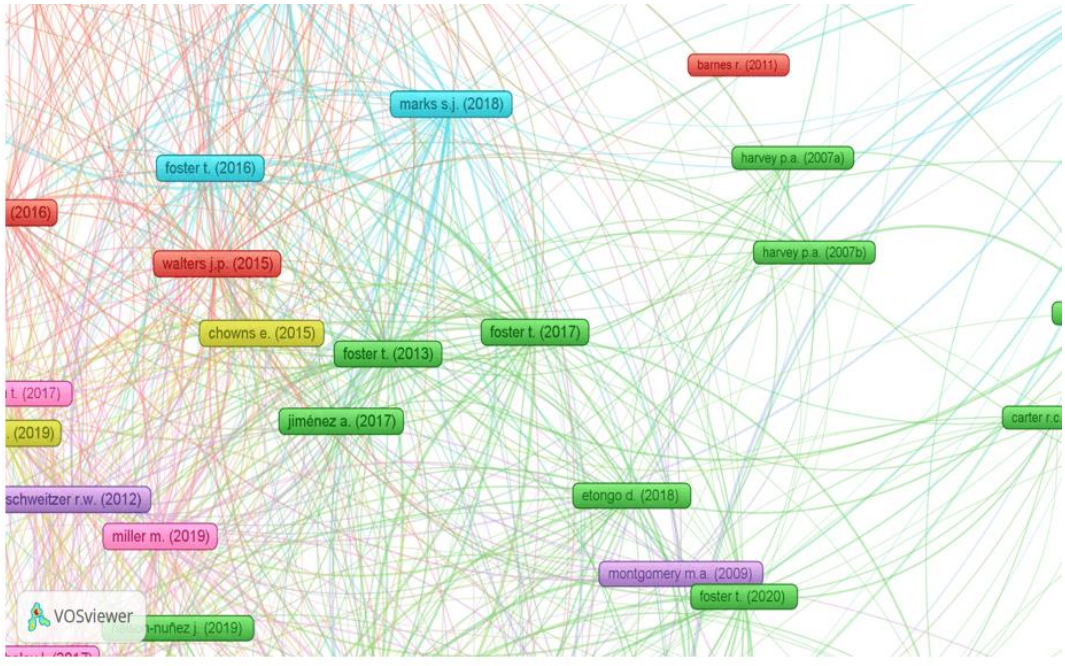

Figure 6. Figure 5 Green Cluster Network

The green cluster comprises a total of 19 papers published since 2006 to 2020. This cluster mainly focuses on nature and challenges faced by operation and maintenance aspects of the rural water scheme. Similar to red cluster, the majority of study pertaining to this cluster also deals with rural water schemes in the Africa. The earliest paper in this cluster from 2006 was a study conducted in Zimbawe which showed that community participation, availability of technical personnel and

training of staff involved in operation and maintenance ensures the longevity of the schemes (Hoko & Hertle, 1/2006). During the initial stages, this cluster akin to the red cluster also dealt with the need of community participation in the operation and maintenance of the schemes. However the studies deviated as a seminal paper by (Harvey & Reed, 2007) divulged the need of distinguishing between community management and community participation. Using the survey conducted across Ghana, Kenya, Uganda and Zimbabwe , the paper showed that focus on community management takes a project based approach where involvement of community is relegated only in formation of water scheme committees, training, setting and collecting tariffs and responsibility pertaining to operation and maintenance. However the paper argues that for long term longevity and sustainability of scheme, community participation is more needed which happens to be a superset of community management and covers other various aspects such as communities' own choice on the type of service they want, followed by financial and labor contribution they have in design. In addition, the community should be involved in selection of technology and even the future management model. Thus community management only focuses on operationalizing the schemes while community participation is more focused on transferring the ownership to the community itself.

But since rural communities don't have all the resources to address this situation, a study in the cluster advocates a more active role of government and donor agencies to support operation and maintenance during the post-construction phase (Foster, 2013). This notion does appear regressive and contradictory as prior studies as mentioned in red cluster, indicates micro management by government and donor agencies creates more inefficiencies (Black, 1998) . On the other hand, a relatively new research shows that adopting a "pay as you fetch" approach where people pay for the water they use rather than the standard flat tariff approach will be more appropriate and efficient in managing operational expenses (Foster & Hope, 02/2017).

Meanwhile a study done in Liberia, Sierra Leone, Malawi and Tanzania questions whether the simplistic approach of assessing the sustainability of rural water schemes based on current functionality of water-point is enough (Carter & Ross, 01/2016). Rather the study suggests that sustainability be gauged through more rich quantitative data such as frequency of abandonment and duration of breakdown which will help create a better picture of the situation. Another study carried out in Cambodia showed that those rural schemes that are located closer to urban cities, adopted new technology and encouraged community ownership were found performing better in terms of functionality and operation and maintenance (Foster et al., 2018).

Despite these recommendations, the recent study still shows that one in four handpumps in rural Africa remain nonfunctional (Foster et al., 2020). Therefore a

seminal paper by (Hope et al., 2020) advocates complete rethinking of entire rural water economics by providing three major policy prescription

i. Instead of maintaining isolated rural water scheme, they need to be networked so as to provide service in scale
ii. Adopt a behavioral approach that nudges people towards valuing the water service rather than taking it for granted thus enabling them to share the cost associated with operation and maintenance.
iii. Recognizing the role of government and donor agencies, these funds should be channeled using a performance based subsidy fund.

The Pink Cluster: Factors that influence functionality and sustainability of rural water schemes

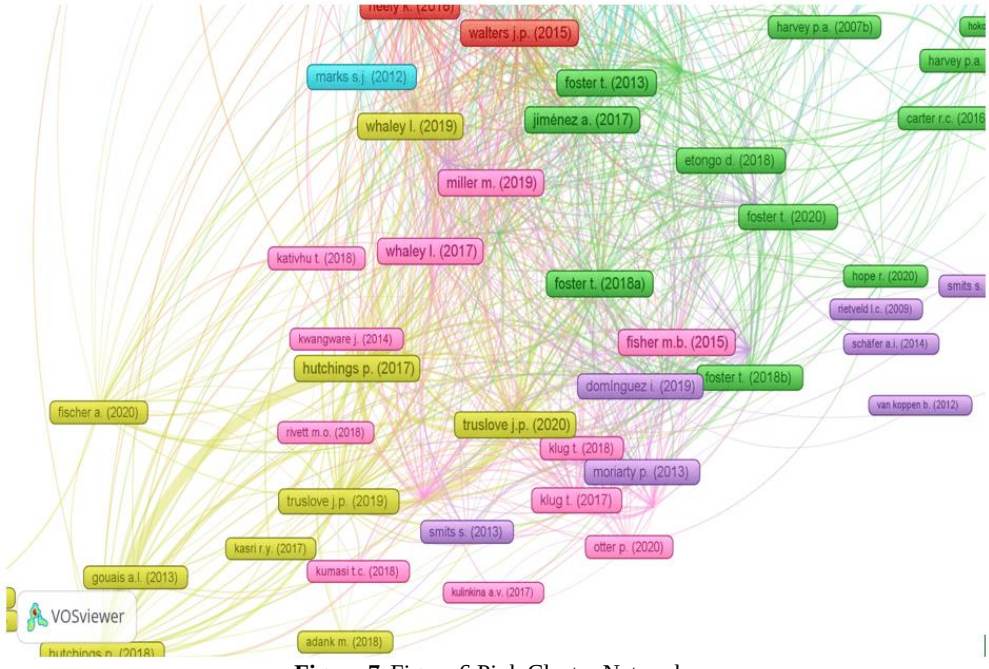

Figure 7. Figure 6 Pink Cluster Network

Under this cluster there are a total of 17 papers which mainly deal with the factors that influence long term functionality and sustainability of rural water schemes. Most of these papers mainly focused on shortcoming from engineering and technical aspects that leads to breakdown and ultimate failure of the system. The initial paper under this cluster is a study carried out in Ghana using Bayesian network model that showed that type of pump used and availability of tools very much determines life of the water points. Especially, the study indicates there exists a dynamic equilibrium between regular breakdown and repairs with management being antecedent of repair rate (Fisher et al., 10/2015). Another highly cited paper in the cluster by (Whaley &

Cleaver, 06/2017) identifies that besides technical factors, relative neglect of local institutions, prevailing socio-economic factors, power dynamics and socio-technical interface are the cause behind the non-functionality of rural water points.

Based on the research of more than 3600 water points in Liberia, Nigeria, Tanzania and Uganda ; (Klug et al., 04/2018) suggest to introduce categorization of rural water schemes based on type of system, age, type of fee collection and type of management style employed so as to isolate the reasons behind the breakdown. In the meantime another study carried out in Ghana, Kenya and Zimbabwe advises to address non-monetary factors such as community assets, institutions and labor to improve the overall functionality of the rural water schemes.

Besides these focus on the provider side, some recent papers in the cluster also suggest that ensuring water quality and making communities aware of health benefits can largely increase the water demand among communities and at same time influence them to upkeep the system's overall functionality (Kulinkina et al., 07/2016). This demand side aspect is important as low water demand from the user impugns the long term viability of rural water schemes as it won't be able to cover its initial cost (Otter et al., 12/2020). The study further suggests that reaching the breakeven point within five years requires private investment which can be roped in only when necessary demand exists.

Another study done in Latin America meanwhile analyzes the failures of rural water schemes from political aspects. The study showed that fragilities of community schemes can be inherently attributed to their lacking political strength (Machado et al., 2019). Hence if these communities are politically empowered then the long term functionality can be ensured. In addition to community awareness and them being politically empowered, a study in Caribbean also shifted the focus of long term functionality towards the year round availability of water source and proper monitoring mechanism (Cronk & Bartram, 09/2018).

Finally, a literature review of 218 publications on rural water functionality indicates that most of the knowledge base in the field suggests that in lower and middle income countries there must exist an External Support Program (ESP) to provide administrative, financial and technical support to contribute for long term functionality of rural water schemes. However, there appears to be a lack of concrete terminology and typology that defines ESP as a result of which the external support programs are not coherently linked (Miller et al., 06/2019).

The Yellow Cluster: Role of planning in rural water schemes

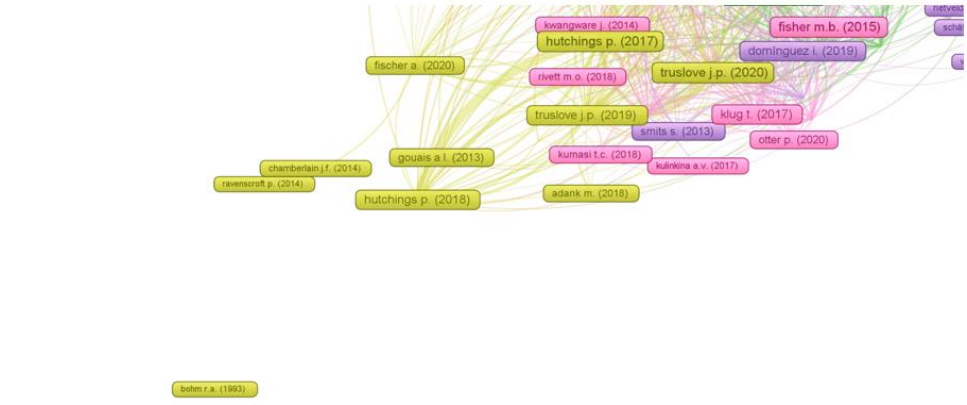

Figure 8. Figure 7 Yellow Cluster Network

The yellow cluster mainly deals with the role of external sectors in establishment and upkeep of the rural water schemes. There are 16 major publications within the cluster with the earliest one being the study done in the Philippines in 1993. The paper applying the contingent valuation method finds that cost per unit is lower in villages with a large user base. Further willingness to pay indicates people prefer the private faucet over the public water point. The study therefore suggests that planning agencies should select those rural areas with larger population bases before constructing the rural water scheme (Bohm et al., 07/1993).

Following this study there was no significant study done in this area for almost two decades with only one punctuated research carried out in Bangladesh which proposed planers to adopt life cycle analysis with respect to technical, economic and environmental analysis to better evaluate the outcome of rural water scheme. This methodology was suggested as it can address both community and social-equity perspectives (Jones & Silva, 11/2009).

Interest on the theme returned only in 2015 with two significant papers being published. A study done in Malawi using a mixed method highlighted the failure of the community management schemes and criticized the government for using a decentralized approach as simply a means to offload its public service provisioning responsibilities (Chowns, 10/2015). It further advised that promotion of local ownership and development should be handled with prudence and care. In the meantime a metaanalysis of 174 case studies of successfully managed rural water schemes posits that long term external support through government or other stakeholders is essential for ensuring the viability of the schemes (Hutchings et al.,

2015).

The more recent studies have also questioned the governments and planner's logic of handing free rein to community managed decentralized rural water schemes. For instance, the government's sole focus on increasing the coverage target as mandated by Millennium development goals, rather than the better infrastructures has seriously jeopardized the overall sustainability of schemes (J. Truslove et al., 2019). This sentiment of focus on numbers rather than quality has been reflected in other studies as well. For instance, a historical analysis done in Ethiopia, Malawi and Uganda concludes that despite the setup of hundreds of thousands of rural water committees have been formed, still the availability of safe drinking water has been a pipe dream. The study thus suggests planners adopt a model different from community managed in order to address the affordable maintenance and repair (Whaley et al., 2019) . Similarly (Hutchings, 2018) using data from 20 different case studies in India, advocates broader states and funding agencies' role financing and service provisioning so as to improve community managed water schemes . It further cautions that relegating persisting issues in rural water schemes as a simply as collective action problem is a big mistake and hence advises to transition from community managed to co-production as a better means of sustainability.

The Purple Cluster: Socio-Ecological factors disrupting rural water schemes

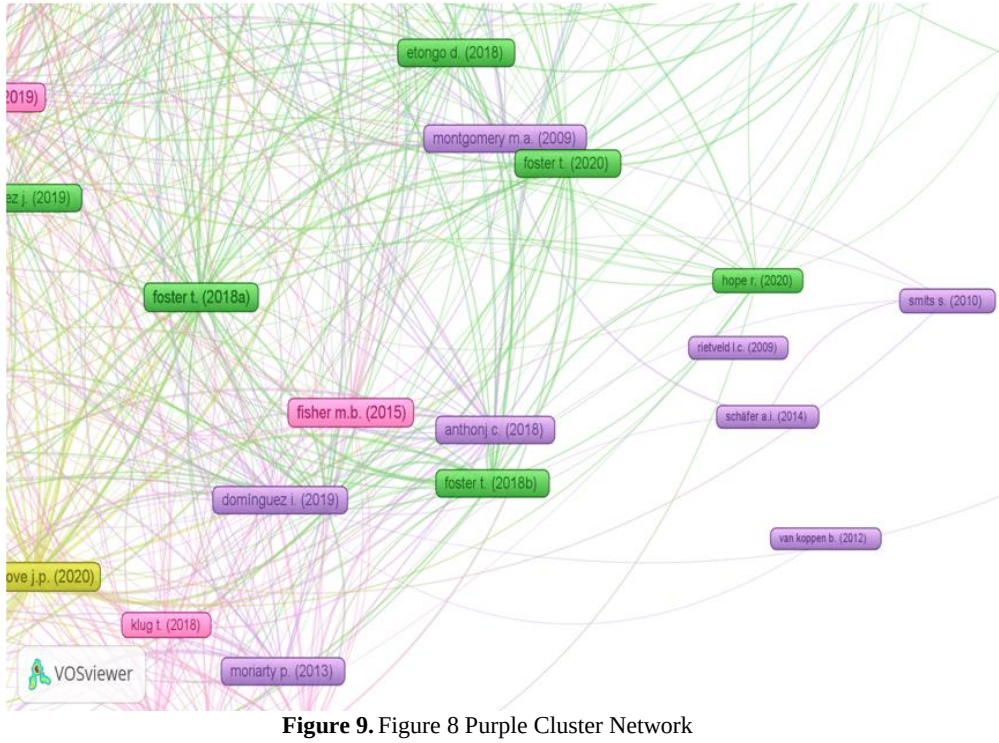

Figure 9. Figure 8 Purple Cluster Network

Contributions included in purple cluster focus on the socio-ecological factors disrupting rural water schemes. The first evidence towards the socio-ecological factors is provided by (Taylor & Howard, 5/1996), according to which most of the rural water schemes are dependent on groundwater recharge which is severely affected by changing rainfall patterns and deforestation. Following this study there was a relative lull in the theme, with another major systematic review carried out in 2009 in Africa showed that to outstand uncertainty behind impact of climate change there is a necessity to strike a right balance between water availability and user demand (Macdonald et al., 08/2009). Especially dispersed water points and those schemes that rely heavily on shallow water sources are more vulnerable to climate variability.

Another literature review carried on same year also suggests that for proper development and environmental balance there is a need for addressing effective community demand, local financing and cost recovery (Montgomery et al., 05/2009). Moriarty et al., (2013) meanwhile spotlighted the need of professionalization of community managed water schemes and sustainable financing to regulate with the externalities. Further, in alignment with the concern raised in yellow clusters, the growing focus on target coverage led decision makers to take short cuts thus putting additional stress on ecology of rural water schemes (MacDonald & Calow, 11/2009).

Besides these concerns, the publications in these clusters also emphasize the need for environmental assessment of sources of rural water schemes before they are implemented. For instance (MacDonald et al., 2008) highlighted the need for better hydrogeological expertise for analyzing whether the rural water schemes in Sub-Sahara Africa is viable before its development. On the other hand, a recent study by (Domínguez et al., 2019) using Multi-criteria analysis and analytical hierarchy process has devised an assessment tool consisting of 17 various attributes with 95 quantifiable indicators for determining the sustainability of rural water supply systems.

The Blue Cluster: Need of Institutional ownership and reform of rural water schemes

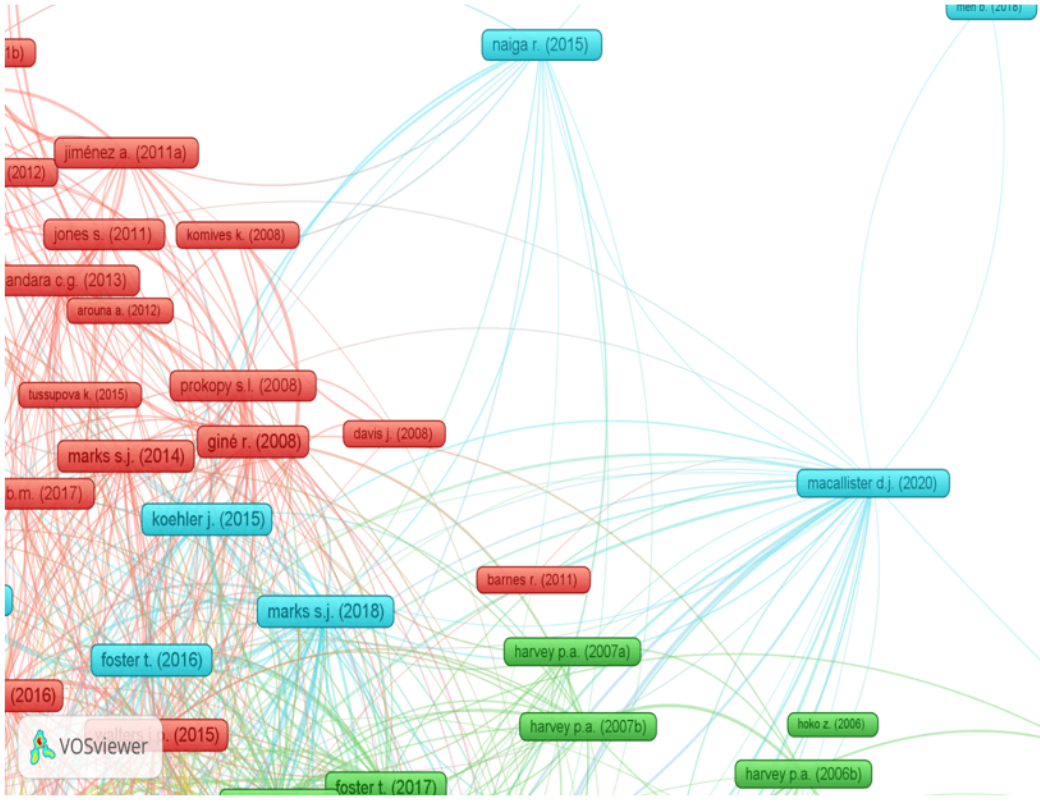

Figure 10. Figure 9 Blue Cluster Network

The final cluster shifts the attention towards the need for institutional ownership of rural water schemes. The earliest study in this theme was done using data comprising 1088 rural households from India and Sri Lanka, according to which community participation augmented by institutional rules, practices and social capital generated by rural water schemes very much determine whether it succeeds or not (Isham & Kähkönen, 04/2002). In fact a study in rural Mali showed that community schemes with consultative participatory approach alone could not guarantee the success; rather it requires a more "platform" approach which provides institutional underpinning through involvement of several social actors, decision makers and technological support (Gleitsmann et al., 05/2007). Similarly another study by (Marks & Davis, 8/2012) in Kenya showed that community participation doesn't necessarily enhance a sense of ownership among the people.

With these considerations, using the public goods theory, (Koehler et al., 10/2015) new institutional forms that could pool the operational and financial risk along with adoption of better monitoring and payment technologies. Furthermore, multi-

decadal study done in Kenya also indicates that there is need of institutional reform to improve the revenue collection system which otherwise leads to shortfall in funds causing length downtime and abandonment of the entire scheme (Foster & Hope, 10/2016). Meanwhile, recent study focuses on developing institutions with economic dynamism that can ensure political and social stability in building rural water schemes which is essential for overcoming long-term environmental problems (Cobbing & Hiller, 10/2019). In fact this cluster very much reflects the clear need of property rights definition for the users using the rural water as explained (Rosegrant & Binswanger, 1994)

Discussion

The overarching theme emerging from the six thematic clusters informs the evolution of both opportunities and challenges pertaining to rural water financing over the years. Especially community managed water schemes that have been de facto modality since post-cold-war has underperformed in its promise. The decentralized demand driven model that keeps the communities at the center and the states and funding agencies at periphery has definitely empowered the communities across the poorest parts in the world that includes Sub-Sahara, Indian subcontinent and Latin Americas. However, these communities seriously lack the financial, technical and managerial resources to handle the exogenous concerns such as climate change, increased water stress and funding to manage regular operation and maintenance. These concerns have overstretched the functionality of these schemes to its breaking point. In this regard the emerging themes have shown that a better understanding is required to bring together knowledge, policy and practice so as to tackle emergent challenges.

The red cluster obtained by the Bibliometric review reveals that the theme of community based management of rural water schemes emerged as a need to address the shortcomings of supply side approach of top down planning. And it also shows that with time community management has proven to provide the instances of several successes across Sub-Sahara, Western Asia and South America. However the recent studies under the theme indicates that though local level demand approach has provided success stories, still they are plagued by inefficiencies because of lack of technical and operational knowhow at community level. Further local politics and lack of democracy complicates the effort resulting in low level equilibrium.

Meanwhile, green knowledge cluster focuses on the specific post construction operation and maintenance financing of rural water schemes and how the model has evolved. It began by acknowledging the limitations of community managed water schemes and by advocating better proactive community participation for ensuring sound functionality. Over the years focus of operation and maintenance shifted more towards technicalities pertaining to proper assessment of functionality and factors

that influence the functionalities. However, it has recently been suggested that rural water projects will never be fully functioning unless they are connected and provide value to their users.

The pink cluster on the other hand considers factors such as engineering, political power dynamics, low demand, lack of labor as factors precipitating towards poor sustainability of rural water schemes. Thus to empower the community in decision making and proper categorization of rural schemes can be the way out for handling these non-monetary factors.

In the meantime, yellow cluster advocates a larger role of government in handling rural water schemes. It challenges the notion that community based managed schemes alone are able to address the sustainability issue and hence support larger investment by the government in building supply chains as required by financial and operational needs of the water schemes so as to achieve the Sustainable Development Goal 6.1 (J. P. Truslove et al., 2020) . This idea of larger government role is also touched by few papers in green cluster

Purple clusters on the other hand deals with socio-ecological stress such as climate change and its impact on the rural water scheme. Especially because of variable rainfall patterns and drying of sources the entire rural water scheme is compromised. In order to address this a need for better environmental and technical assessment is required prior to setup of the scheme. Also singular focus on quantity rather than quality is further detrimental to the longevity of the overall schemes.

Finally the blue cluster provides a backdrop for the need of more institutional reforms to make the rural water schemes more environmentally sustainable and financially viable for the future. As per the studies in the cluster the current institutional framework of community managed schemes under the supervision of government and donor agencies is not adequate. Rather a new institutional structure needs to be identified that can best make the scheme better and can address its survival needs.

It is however important to understand that these clusters are very much cross cutting. As shown in Figure 1, citations of paper from one cluster to another are pervasive. In this regard dissecting the entire knowledge base to these different clusters helps to isolate intra-cluster nuances and at same time help identify the inter-cluster connection as well. Thus it should be understood that these clusters are tightly coerced and at same time loosely coupled.

Conclusion

Rural water financing is a subject that has evolved over years and has gained more traction in recent years attributing to climate change and renewed interest in decentralization and collaboration at community level. In addition this increased interest is very much aligned with the UN sustainable goal 6.1 of providing access to safe drinking water to all (Hutton & Varughese, 2016). In this backdrop, the Bibliometric review using the Bibliographic Coupling strategy shows that most of the studies in the current domain are concentrated in Sub-saharan regions and there have been few studies done in Latin America followed by Asia. Considering the fact that 4.32 billion people live in South Asia and South-Eastern Asia, majority of who live in abject poverty it is essential that more studies concerning rural water financing and its prevailing nature in the region is important especially to unravel domain awareness gap[1]

Since the domain purview is very wide, it is better that the future studies be carried out in a cluster wise manner. Especially it is important to figure out the customer, payer, user and owner of the rural water scheme so as to determine their limitations and capabilities of each actor and their interrelationship. Further it is important to connect these mechanism with existing theories and philosophical treaties governing the existing knowledge base concerning operation and maintenance of public or common pool goods such as rural water schemes.

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