Community-Centric Metric for Watershed Effectiveness Evaluation

A thesis submitted by

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Statement

I, the undersigned, declare that the research embodied in this thesis entitled "**Community-Centric Metric for Watershed Effectiveness Evaluation**" is the result of a field study carried out in the School of Agro & Rural Technology, Indian Institute of Technology Guwahati, India, under the supervisions of Prof. Arup Kumar Sarma and Prof. Sashindra Kumar Kakoty.

In keeping with the general practice of reporting scientific observations, acknowledgements have been made wherever the work described is based on other research findings.

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Certificate

This is to certify that the work described in this thesis entitled **"Community-Centric Metric for Watershed Effectiveness Evaluation"** by Bhabesh Mahanta (Roll No. 166154101) for the award of the degree of Doctor of Philosophy is an authentic record of the result obtained from the research work carried out under our joint supervision in the School of Agro & Rural Technology, IITG. The work carried out in this thesis has not been submitted elsewhere for a degree.

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Abbreviations

Symbols	Definitions
AWRM	Adaptive Water Resource Management
BC ratio	Benefit Cost Ratio
CBO	Community-Based Organisation
CP	Community Participation
CRP	Community Resource Person
DO	Divisional Officer
DoLR	Department of Land Resources
DPR	Detailed Project Report
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EPA	Entry Point Activity
FAO	Food and Agricultural Organisation
GIS	Geographical Information System
GP	Gram Panchayat
GPS	Global Positioning System
GS	Gram Sabha
Ha	Hector
IWM	Integrated Watershed Management
IWMP	Integrated Watershed Management Programme
IWRM	Integrated Water Resource Management
KPI	Key Performance Indicators
MELD	Monitoring, Evaluation and Learning Department
MIS	Management Information System
MoA	Ministry of Agriculture
MoRD	Ministry of Rural Development
MSW	Micro Watershed
NGO	Non-Government Organizations
NITI Aayog	National Institution for Transforming India Aayog
NRM	Natural Resources Management
OECD	Organisation of Economic Cooperation and Development
PIA	Project Implementing Agency
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PRA	Participatory Rural Appraisal
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SHG	Self Help Group
SLNA	State Level Nodal Agency
UG	Users Group
UNDP	United Nations Development Program
WC	Watershed Committee
WCDC	Watershed Cell cum Data Centre
WDC	Watershed Development Council
WDF	Watershed Development Fund
WDT	Watershed Development Team
WOT	Watershed Organizations Trust
WTC	Watershed Technical Committee
WTCG	Women Thrift and Cooperative Group

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Abstract

This research aims to create a community-centred metric to evaluate and enhance stakeholder participation in watershed projects. This analytical tool will establish a scientific connection between the watershed project's success and community participation efforts, examining the alignment between the perspectives of project planners and users.

Governments and institutions worldwide are implementing watershed programs through the Integrated Watershed Management Programme (IWMP) and Integrated Watershed Management (IWM), focusing on a collaborative approach through multi-stakeholder networks and partnerships involving various actors like international agencies, regulatory bodies, NGOs, municipal governments, and community-based organisations. Regular evaluations and feedback from the participant community's perspectives are crucial for programme effectiveness and sustainable resource utilisation.

Practically, it is difficult to informatively examine the issues involving community participation (CP) in watershed programmes for two principal reasons: First, there is no primary data available, as most policymakers often do not include proper CP assessment procedures in their protocols; Second, there is a shortage of well-defined indicators or indexes at the project level against which community perceptions could be determined, though the community members are the best assessor regarding the effectiveness of a watershed project. Policymakers typically measure watershed success with indicators based on built assets by top-down sectoral assessments, which might not align with stakeholders' observations. Instead, the effectiveness of a watershed project is directly correlated with the degree of unity in stakeholders' perceptions and their willingness to continue rather than with policy priorities. So, a question arises: Can watershed project effectiveness be evaluated from the stakeholders' perspective, which will provide vital community information for sustainable participation?

This research hypothesises that a community-centred metric may evaluate watershed

project effectiveness by integrating indices constructed on stakeholders' desirability, degree of participation, organisational efficacy, and participatory performance.

Three IWMP projects were selected as research laboratories for empirical study based on the protocol similarity, regional and socio-economic features analogy, and representing both rivers of the River Brahmaputra, Assam (India). Before applying a qualitative and participatory research method, watershed effectiveness variables were identified to understand better the nonalignment between community perceptions and planners' actions in watershed planning, implementation, and organisational management. Incorporating the relevant variables, four unique participation evaluation frameworks are developed to measure four community-related watershed stressors: project desirability, performance, effectiveness of the community participation mechanism and managerial effectiveness of the project.

The data collection process involves a series of field visits across the watershed project areas, supplemented with expert interviews, focus group discussion, and opinion surveys amongst the stakeholders' groups, with a classified random sampling method using structured questionnaires to capture complex and challenging-to-quantify issues related to participation procedures, institutions, gender relations, and inclusion.

Incorporating appropriate statistical analyses, four evaluation frameworks were constructed to reflect the heterogeneity of insights prevailing in watershed participant groups about four community-related watershed project phases: Planning, Organising, Implementing and Managing. The main outputs from the field data collection provided findings on the nature of community perceptions in project areas, compared against a backdrop of standard features of targeted community participation. Then, the phase-wise indices are aggregated to obtain a single integrated watershed index that can be a powerful metric to reflect directly the state of affairs of the community participation mechanism adopted by the watershed managers and, indirectly, the project effectiveness.

The developed methodology on effectiveness indexing might help eliminate the challenging participation bottlenecks in watershed management and design specific operational phase-wise interventions for process reengineering from stakeholders' perspectives.

The metric and methodology might be transformed to a comparing scale supplementing with further field studies for generalising over a broader region. Further, a similar analysis might be adopted to improve the alignment of stakeholders' perceptions in other multi-stakeholder developmental programmes where incongruencies commonly exist.

Besides the Introduction, Review of Literature and Conclusion, this thesis contains five chapters on developing and aggregating different indexing methods.

Chapter 1 Introduction

1.1 Background

Since the mid-20th century, watershed management has developed as a holistic river basin planning, covering economic analysis ranging from cost-benefit studies to socio-cultural benefits (Conservation Ontario, 2010). Integrated Water Resource Management (IWRM) and Integrated Watershed Management Programmes (IWMP) have evolved into widely accepted policy initiatives for watershed management. IWRM is a process that promotes the coordinated development and management of water, land, and related resources to maximise the resultant economic and social welfare equitably without compromising the sustainability of vital ecosystems (Technical advisory Committee, Global Water Partnership, 2000). Adapting two significant principles from IWRM (namely, ecosystem preservation and socio-economic welfare), IWMP envisions watershed projects as community-based development programmes aiming to balance human activities like agriculture, urban development, and industry with natural processes for preserving ecosystems, biodiversity, sustainable land use, community involvement, and adequate water security (NITI Aayog, 2019; Gaur & Milne, 2015; SLNA, 2010c).

Operationalising water management principles in practice is complex, mainly because i) the intricacies of IWRM are diverse; most are non-specific, dynamic and incomprehensible (Biswas, 2009; Giordano & Shah, 2014; Petit, 2016), and ii) watershed programmes are propagated as multistakeholder community-development platform involving interconnected communities and ever-changing environment-based economies (FAO, 2017; OECD, 2014; United Nations, 2015).

Some significant constraints of collaborative watershed management arise mainly from the critical attributes inherent to the subject. They are:

a) Absence of universal design: The definition and concepts of IWRM always remain amorphous and imprecise, resulting in feeble consensus on fundamental questions such as what aspects should be integrated, how to do it, by whom, or even if comprehensive integration is feasible (Biswas, 2009; Giordano & Shah, 2014; Woodhouse & Muller, 2017).

b) Difficulties in governance due to misalignment of stakeholders' perception: Involving diverse stakeholders with varying socio-cultural perspectives poses a challenge for water managers when choosing alternatives and creating fair governance, as they are seen differently by various stakeholders (United Nations, 2002).

c) Defining watershed Success/effectiveness and framing a community-centred metric for its evaluation: Watershed success is enigmatic. Very often, the definition of watershed success raises complex issues. The metrics development for evaluating watershed performance have also grown more complex as watershed initiatives expanded in scope (Giordano & Shah, 2014; Kenney, 2000; Kerr, 2007; Kerr & Jindal, 2004; Koontz, 2014).

As such, literature shows no universal best way to govern watershed organisations. So, the pivotal takeaway is that governments at various levels (particularly at the local level) should facilitate dynamic outcome assessment to minimise stakeholders' disagreements and conflicts.

Consequently, to address current and future challenges, the UN (United Nations) and OECD (Organisation of Economic Cooperation and Development) emphasise the need for clear public policies with measurable objectives, assigned responsibilities, and regular monitoring and evaluation (Heathcote, 2009; Leach, 2006; UNECE & OECD, 2017).

1.2 Centrality of Community Participation (CP)

It is widely accepted that watershed management is best carried out as a stepwise multi-stakeholder process involving community-based organisation, and watershed effectiveness correlates directly with participants' willingness to continue. The watershed management problem intensifies as the participants' interests change for various reasons, such as socio-political behaviour and institutional change. Researchers broadly agree that success will remain elusive if the policies are not supported by community-centric action planning at the project level.

While studying the assessment of watershed effectiveness, Kenney noted that collaboration, consensus and stakeholder participation were the most frequently cited keys to success (based on survey data from participants in 118 watershed initiatives) (Kenney, 2000). Many authors identified and analysed the forces affecting water management to suggest various issues for success, and there is a remarkable consensus among them (Asthana, 2010; Bertule et al., 2017; Geressu et al., 2020; Mohamed et al., 2015). Policymakers believe that enhancing community participation (CP) is more central than propagating a watershed policy. Like other countries, in India. The watershed programme revolves around two major themes: participatory community development and natural resource management. Beginning in the 1970s, the government of India has been running collaborative watershed development programmes (Kerr, 2007). Since the previous highly technocratic approach failed to address the challenges of watershed governance, a more participatory approach through community-based organisations has been adopted since the 1990s (Gaur & Milne, 2015; Nagaraja B, 2015; Smyle et al., 2014; Sreedevi et al., 2008). After various policy revisions in 2009, watershed development programmes were consolidated and renamed IWMP. The policy evolution continues, with the latest development being the forthcoming integration of IWMP with a new centrally sponsored micro-irrigation scheme by the Ministry of Agriculture (MoA) – the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) (Directorate of Soil Conservation, Government of Assam, India, 2023).

1.3 Motivation for the study

Despite community participation and community-based management being accepted as topical themes in current watershed policy and discussion around the decision-making process, the main challenge has been its achievement.

However, policymakers and researchers primarily attempt to improve watershed programs rather than investigate whether the initiatives are fulfilled (Akhmouch & Clavreul, 2016). Usually, the watershed success report focuses merely on organisational achievements based on a fund-utilisation statement and the quantity of the assets created, commonly assessed by top-down methods supported by MIS (Management Information System) and GIS (Geographic Information System) technologies (NITI Aayog, 2017); rather than participatory reporting and stakeholders' feedback on utility. Therefore, examining the 'keys to success' is valuable but somewhat limiting if the real goal is to evaluate the initiatives' effectiveness (Kenney, 2000).

From these perspectives, a resilient community participation mechanism (CPM) accommodating stakeholders' changing requirements in watershed programmes to minimise disagreements regarding various project functions is imperative.

For this reason, watershed managers should constantly synchronise the project objectives, organisational actions and achievements to match stakeholders' willingness to continue. Subsequently, the primary questions before the watershed managers are:

How should community participation be done? How can local people get involved in the complexities of planning, designing and managing the water resource issues? How do the watershed managers synchronise locals' knowledge, institutions, and aspirations to enhance cooperation? How do they detect and align stakeholders' perceptions of project objectives, enhancing their willingness to participate and effectiveness?

The biggest hurdle in answering these questions arises from the region-specific variations of watershed projects while evaluating watershed performance from the community perspective, for which literature shows no universal best ways (FAO, 2017) except broad principles. There is a shortage of research on developing methods to evaluate the degree of alignment of watershed stakeholders' perceptions or index project desirability. Researchers primarily attempt to improve watershed programs rather than investigate whether the initiatives are fulfilled (Kenney, 2000). The watershed managers' report mainly focuses on organisational success based on budgetary expenditures and the quantity of the assets created, commonly assessed by top-down methods. Even present-day monitoring systems using MIS (Management Information System) and GIS (Geographic Information System) technologies (NITI Aayog, 2019) are top-down measures. Contrary to this, if managers can ascertain the degree of fulfilment of the project targets with participatory reporting and stakeholders' feedback on utility, they will be very close to the success or failure scenario. This is because success must ultimately be assessed by what happens on the ground and from the community's standpoint.

Thus, a more disaggregated and less normative region-specific approach to the analysis of watershed participation is required to create an understanding of the conditions under which participatory approaches may enhance watershed effectiveness. Therefore, developing an integrated indexing system for effectiveness evaluation is imperative by aggregating community information in project operation phases.

Nevertheless, another hurdle for these innovations lies in their inherent region-specific nature. Therefore, the fundamental skills of water professionals are constantly tested against their ability to build a resilient community participation mechanism to cater for stakeholders' changing requirements. In this context, the problems before the watershed managers are two-pronged. They are:

i) Identifying the key socially resilient community participation variables specific to a watershed project and

ii) Assessing in what exact way each of the community participation variables influences the project's performance.

Although community participation has been a cherished goal for watershed managers, there is a shortage of studies to evaluate watershed performance from the community perspective.

There is also no study to evaluate the nonalignment of stakeholders' perceptions or to develop an integrated indexing system to aggregate community information prevailing in different project operation phases.

Consequently, it is imperative to identify a set of community participation variables for a sustainable IWMP project and an analytical tool (metric) to establish a scientific interrelationship between these community variables and watershed performance. Such a tool will be convenient for watershed managers to handle community participation towards sustainable development.

1.4 Aim of the study and research hypothesis

This study aims to develop community-centred frameworks for evaluating stakeholders' perceptions in different watershed project operation stages and to aggregate the indices to formulate a metric for appraising participation effectiveness. The research hypothesises that a community-centred metric can evaluate watershed effectiveness by integrating indices constructed on stakeholders' desirability, degree of participation, organisational effectiveness, and participatory performance indexing. This hypothesis is validated in three watershed projects in Brahmaputra Valley, Assam, India.

1.5 Objectives

The objectives for achieving the research aim are:

1. To develop and validate watershed project desirability index (WPDI) for evaluating stakeholders' appeal for watershed projects.
2. To develop and validate a community participation evaluation framework (CPEF) and community participation index (CPI) for evaluating the

degree of effectiveness of the community participation mechanism adopted by watershed managers.

3. To develop and validate a watershed project performance index (PI) for evaluating project performance.

4. To develop and validate a watershed management index (WMI) for evaluation of the involvement of component organisations.

5. To aggregate different indices (WPDI, CPI, WMI, and PI) to obtain an integrated watershed matrix (IWI) usable as a metric for improving community participation in watershed projects.

1.6 How this research is carried out

Lord Kelvin once observed, "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it when you cannot express it in numbers, your knowledge is meagre and unsatisfactory." (Saxon, 2007).

Acknowledging Kelvin's observation, is it feasible to measure watershed stakeholders' desire to continue with the programmes? To realise this, some quantitatively expressive frameworks and methods based on analysis of the effects of stakeholders' perception in the planning, organising and quality-of-service provisions in watershed programmes might be helpful. These comprehensive frameworks, if aggregated, could provide an integrated watershed index to reflect project effectiveness and compare outcomes of homogeneous projects. Besides providing a means to measure participation, the methodology would be of value for micro-level understanding of the forms of involvement in developing an appropriate participation typology.

So, watershed policymakers should identify the key domains and sub-domains for a sustainable project based on commonly accepted IWMP principles in congruence with regional specificity. The broad steps for framework development can be envisaged as depicted below:

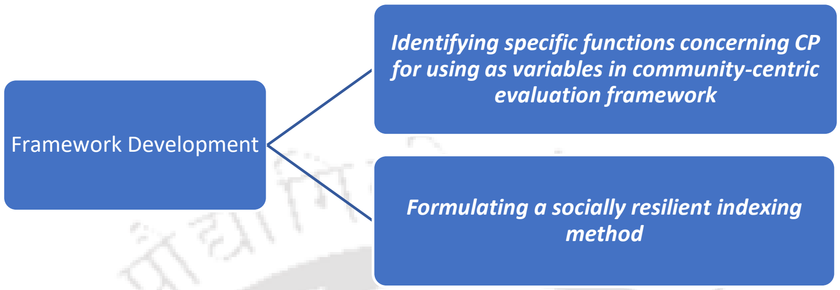


Fig. 1.1 Steps for framework development

It is essential that enhancing CP should continue throughout all the community-centric project phases by adopting appropriate functions as outlined here: a) Project planning should incorporate examining the stakeholders' desirability regarding the planned importance or project parameters. b) Organising should involve initiating an adaptable community participation mechanism (CPM) fitted with organisational actions and facilitating inter-organisational managerial function sharing and involvement. c) Implementation and service delivery should be guided by community information about achievements and social learning. Therefore, the study approach necessitates a thorough understanding of community involvement in planning, organising and implementing, for which an extensive field survey is required. Subsequently, operational areas concerned with community involvement are studied in three watershed projects (Kaldia IWMP, Satpokholi IWMP and Turkunijan IWMP) in Brahmaputra Valley, Assam, India.

1.7 Scope of the research

The developed frameworks have inputs from international watershed policies and empirical studies of IWMP projects in Brahmaputra Valley, Assam (India) and have been validated in three selected projects with analogous regional settings. The local watershed project-level infrastructural knowledge and community information are extracted from the State Level Nodal Agency (Assam) (SLNA) documents, the Department of Land Reform and Soil Conservation, and NITI Aayog (Government of India). Although the experimental focus is primarily on India, the methodologies are more generally relevant.

1.8 Significance of the research

The success of community participation in developmental activities like watershed programmes is hard to comprehend. This study is significant due to the following potentials.

i) It strives to identify socially resilient community participation variables set in different project phases from community perspectives. These sets and the developed evaluation methodologies might apply to projects in similar regional settings. In the methodologies, the primary qualitative information, like perceptions of community groups, is converted to adapt to a quantitative framework for indexing and evaluating the stakeholders' desirability – which is unique.

ii) Unlike the commonly used top-down watershed assessment, this research proposes a bottom-up assessment approach that reflects stakeholders' perspectives.

iii) The developed frameworks might help the project-level watershed managers to

a) appraise the community's desirability at the planning level, b) configure adoptable community actions, c) gather community feedback and support in project performance, and d) evaluate the involvement of Community-based Organisations (CBOs) in project managerial functions.

iv) The developed frameworks have the potential for ex-ante and ex-post applications.

Ex-ante, the frameworks could be applied to a particular sector to systematically understand the forms of local participation and to feed this information into the design of subsequent programmes and projects. Ex-post, the frameworks could also be applied as an evaluation tool. Accordingly, the participatory tools can generate critical data to detect insufficient attention and negative implications in the programme implementation.

v) The embedded procedures in the integrated indexing method will empower managers and participants to comprehend the composite change in operations, behaviour, and social relations within a community and, hence, be valuable for informing government and stakeholders in restructuring resource planning and policy-level service delivery. With proper implementation of a participatory tool like this, new behaviour and social learning may evolve through practising and following up, even without direct coercion.

vi) The methodologies can be modified to examine the involvement in programmes like community engagement in public health, environmental conservations, etc. or be used more generally – for instance, about participation in the planning, delivery, monitoring and evaluation of a service – where misalignment of stakeholders' perceptions exist.

1.9 Thesis organisation

The content of the thesis is organised into eight significant chapters, in addition to the abstract and references. Chapter 1 covers the introduction, research scope and objectives of the work. Chapter 2 presents a review of the literature. Chapter 3 presents the development and validation of WPDI for watershed planning operations. Chapter 4 contains the story of the development and validation of CPEF and CPI for watershed organising operations. Chapter 5 describes developing and validating a Performance Evaluation Framework and PI for the watershed implementation phase. Chapter 6 presents the development and validation results of a watershed management index. Chapter 7 presents the aggregation of different indices in developing an integrated watershed indexing method for enhancing effective community participation in watershed space and the interaction effect between WPDI, CPI PI and WMI. Chapter 8 presents the summary and the major conclusions from this study, followed by some suggestions for future work.

Chapter 2 Review of Literature

2.1 Introduction

The research aims, scope and objectives have been presented in Chapter 1. Subsequently, exploring the state of the art in conducting the research is imperative. Considering all the theoretical developments based on the objectives of this research, a detailed literature study is presented in the current chapter. The review has been presented section-wise as outlined below:

2.2 Mapping the key community participation features of IWMP projects selected for the study.

2.3 Mapping watershed project performance variables based on globally accepted protocols and examining the community's agreeability.

2.4 Studying watershed community-based organisational structure and identifying community participation variables for effective engagement.

2.5 Mapping watershed project performance variables based on local watershed projects' goals and achievements viewed from community perspectives.

2.6 Evaluation of participant watershed organisations' functional involvement and managerial effectiveness.

2.7 Metric development: Aggregating sub-indices for developing Integrated Watershed Index (IWI)

2.8 Summary of the current chapter.

2.1.1 Background

The Atharva Veda text from 800 BC contains what may well be the first written reference to watershed management. Atharva Veda verse 19, 2.1 states that: "one should take proper managerial action to use and conserve water from mountains, wells, rivers and also rainwater for use in drinking, agriculture, industries" (Chandra S 1990; Wang et al., 2016).

However, watershed management as a holistic concept was not defined until the mid-20th century. In recent years, water resource management policymakers have favoured the principles of integrated water resource management (IWRM) and integrated watershed management programme (IWMP). The Global Water Partnership TAC Background Paper (2000) (Technical Advisory Committee, 2000) defined IWRM as a "process which promotes the coordinated development and management of water, land and related resources, to maximise the resultant economic and social welfare equitably without compromising the sustainability of vital ecosystems." Food and Agricultural Organisation (FAO) defines a watershed as a geographical area drained by a watercourse, and watershed management is any human action that ensures the sustainable use of watershed resources (FAO, 2017). Like IWMP, Integrated Watershed Management (IWM) is defined as managing human activities and natural resources in an area defined by watershed boundaries to protect and manage natural resources and their functions today and in the future (Conservation Ontario, 2010). The fundamental principle behind IWM is Adaptive Environmental Management (AEM). AEM is a continuous and recurrent process of carrying out a plan and associated interventions to implement, monitor, report on, and update as essential to adapting to changing or new evolving stressors.

Through IWRM and IWMP guidelines, governments and institutions worldwide run watershed programmes through networks and partnerships. These networks and partnerships involve diverse actors like international agencies, national regulatory bodies, non-governmental organisations (NGOs), municipal government and CBOs to define policy, pool resources, and deliver services (or other goods). Nowadays, it is a common point for watershed policymakers that development is about improving people's well-being, giving them a say in the decisions that affect their lives, and expanding their self-determinations, adoptions and prospects (Conservation Ontario, 2010).

Although it has been around 70 years since it was rediscovered in the 1990s, the concept of IWRM is still relatively amorphous. Sometimes, IWRM is considered a 'nirvana' concept, which defines ambitious objectives in an ideal world that cannot be met in the real world (Petit, 2016). Experts argue that IWRM is exceedingly difficult to make operational (Biswas, 2009) due to the complexities in standardising IWRM parameters regarding appropriateness, promotion, development, and monitoring. IWMP adopts two major IWRM concepts: the social, economic, and environmental issues of the watershed zone are the focus area (Kenney, 2000), and the active involvement of community members and organisational representatives is indispensable to tackling inequities (Barbara et al., 1998). Based on survey data from 118 watershed initiatives, Kenny commented that collaboration, consensus and stakeholders' participation are the most frequently cited keys to success (Kenney, 2000).

In this context, many researchers have discussed the constraints to community participation.

Community participation evaluation and its improvement are very complicated due to the following reasons: a) the Highly dynamic nature of the ecosystem, b) the Involvement of multiple stakeholders with differing levels of power and influence, c) Differences in geographical scales, and d) the Difference in socio-cultural perspectives and values (Adams et al., 2005; Bracht & Tsouros, 1990). The involvement of diverse stakeholders and the difference in their socio-cultural perspectives brings real challenges to the water managers in designing and launching legitimate and appropriate evaluations. Perceptibly, there can be many types of assessment that look from multiple perspectives and are initiated by international development organisations, central government institutions, municipalities, participating communities, or external evaluators, each of whom may have their criteria for effectiveness (Alvarado & Bornstein, 2018). Subsequently, evaluating from all perspectives is unrealistic, and considerable arguments exist regarding the appropriate evaluation framework (Span et al., 2012).

Discussing the framework for analysing methods of participation, the Oxford Policy Management Report observes that "Qualitative and participatory research methods are the best suited to capture information on issues that are more complex, sensitive and difficult to quantify using more traditional quantitative research methods. Issues around participation, power, gender relations, and inclusion are intangible and often difficult to precisely or measure objectively or unambiguously. Qualitative and participatory methods enable researchers to understand better the underlying causal links of interventions and how and why things happen the way they do" (Jones & Kardan, 2013). Jones and Kardan further commented that in any participatory process, the proper approach and framework for analysis of participation depend on the following: i) The nature of the sector and the programmes, ii) Specific subjects and the inherent complications, and iii) Whether the framework is part of a scoping or design process applied (ex-ante evaluation) or as part of an effect analysis (ex-post evaluation). In the ex-ante approach, the framework might be used to systematically understand local participation in a particular sector that may inform or feed into the design of a programme or project. The ex-post approach might use the framework as an evaluation tool (Jones & Kardan, 2013).

Since this study is intended to develop an integrated community participation index and metric combining various critical determinants of the watershed, both pre-operational and post-operational, the methodologies developed in this study may be used ex-ante and ex-post.

As mentioned in the first chapter, this study aims to develop a participatory evaluation metric for different dimensions of CP in IWMP programmes operationalised in Assam, India.

An extensive literature study is done to understand the project-level organisational structure in this context. Some essential features are summarised in the following section.

2.2 Key features of project-level watershed organisation in Assam (India)

The watershed programme has been recognised as vital to India's economic growth, the well-being of its people, and the sustainability of ecosystems. Over the last few years, the Government of India and State Governments have been implementing various projects focused on groundwater recharge, responsible use of water for agriculture, and technologies such as micro-irrigation (Smyle et al., 2014). Similarly, various legislation has been enacted promoting water-efficient energy production and discouraging water pollution by industry. More significantly, the Government has consolidated institutional structures at multiple levels – National, State, District and Project – under the Ministry of Jal Shakti to bring interrelated water management functions together and drive more effective outcomes (NITI Aayog, 2019).

The project-level organisations are multi-stakeholder platforms constituted by the Government and NGOs, peoples' representatives and, more importantly, the local community or end-users. The CBOs (Community-based Organisations) form the backbone of the participatory process (Directorate of Soil Conservation, Government of Assam, India, 2023).

In Assam, the State Level Nodal Agency (SLNA) has a governing council under the chairmanship of the Additional Chief Secretary to the Government of Assam in the Department of Soil Conservation. For each IWMP-Assam project, a Programme Implementing Agency (PIA), usually headed by one Divisional Officer of the Soil Conservation Department, Assam, is created (Fig. 2.1).

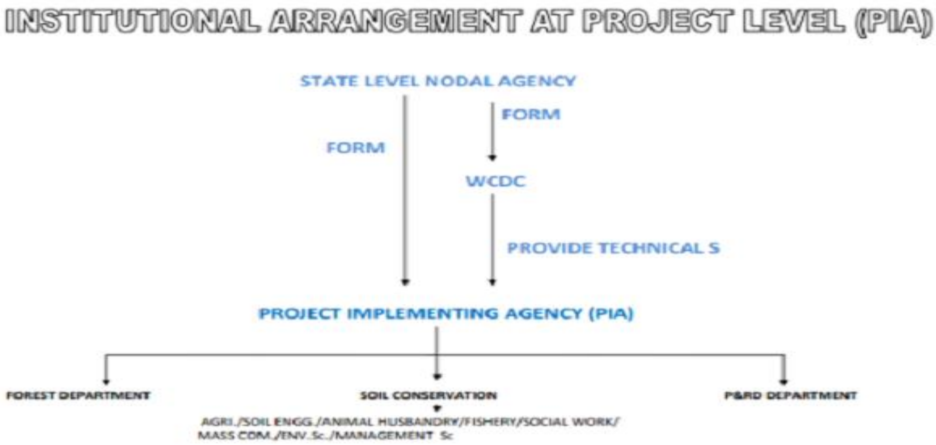


Fig. 2.1 Institutional arrangement of PIA

(*Website:https://slnaiwmpassam.gov.in/*).

The PIA is responsible for technical feasibility, budgeting, estimating, and implementation. The monitoring part is entrusted to a third-party agency directly appointed by SLNA. In an IWMP project, the PIA should form a Watershed Development Team for technical management (Fig. 2.2).

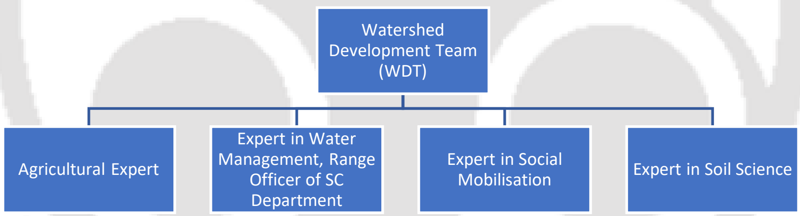


Fig. 2.2 The present organisational structure of WDT

Besides, the PIA should entrust Gram Sabhas of the project area to create watershed Councils, with ten members from the village community/volunteers in each Council. Sometimes, the whole watershed area under the project is divided into more than one micro watershed (MSW), and the council should represent each of the micro watershed zones well. The council should have one chairperson, one secretary, and a few members from different sections of the society, as well as CBOs (Fig. 2.3) (SLNA, 2010c).

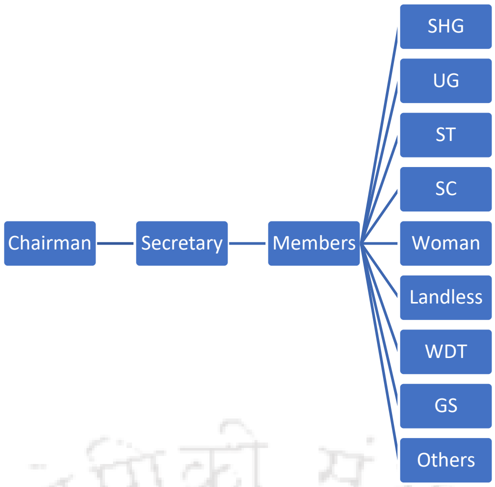


Fig. 2.3 Structure of WDC as defined by SLNA

The IWMP protocols emphasise that the CBOs should include landless, marginal, small farmers and women. A CBO called Self Help Group (SHG) is formed at many IWMPs with women as its primary members. They are expected to be active in actions on the livelihood components of the IWMPs (SLNA, 2010a).

Policy guidelines and IWMP documents also accept that there should be collaborations among local government organisations like Zila Parishads, Gaon Panchayatas, and schools and clubs. Besides, participation by different financial institutions operating in the area is expected to educate and guide the stakeholders. The prescribed model of IWMP project participant organisations, their members, and defined activities are shown in Table 2.1.

Table 2.1: The project participant organisations, their members, and activities

IWMP Participant	**Members**	**Defined Activity**
Watershed Development Team (WDT)	The team members are government employee	We are providing technical assistance to the watershed activities and overseeing project implementation.
Watershed Development Committee (WDC)	Ten members (including one chairman, one secretary, and members from General/SC/ST and other CBO selected by Gram Sabha)	Project implementation activities
Self-Help Group (SHG)	Village Producers Cooperative Committee, Women's Group	Implementation of livelihood schemes

Villages/Users	Users of the watershed activities	Beneficiary
Gram Sabha	Elected local government	Formation of WDC in collaboration with the PIA
Project Implementing Agency (PIA)	Government Departmental Officer selected by SLNA	Project planning to implementation.

2.3 Mapping watershed project performance variables based on globally accepted watershed protocols and examining community agreeability

Globally, water managers and policymakers have tried to identify key performance indicators based on commonly accepted principles and in unity with regional settings. Heathcote (Heathcote, 2009) suggested formal watershed modelling based on standard watershed inventories, like a) Use impairment and water conflicts, b) Hydrology, biology, and water quality, c) Population and land use, and d) Facilities and infrastructure. Reviewing a good number of literature sources, Hooper B. identified i) 34 attributes of best practices, ii) 15 river basin management problems, iii) 115 universal performance indicators of IWRM in ten categories, iv) 20 IWRM benchmarks for the River Basin Commission in eight categories (B. Hooper, 2010). The planning body of the Government of India (NITI Aayog) has proposed a Composite Water Management Index as a helpful tool to assess and improve the performance of water resources management. It suggested a set of 28 Key Performance Indicators (KPIs), expecting the index to generate better outcomes by meeting the citizens' expectations (NITI Aayog, 2019a). Besides identifying challenging hydrological parameters, studying their interdependencies is valuable for sustainable watershed modelling. Factors like urbanisation and population growth influence the mismatch of watershed service delivery's demand and supply side (Shukla et al., 2020). Many researchers have documented critical assessments of the spatial variability of watershed parameters essential for modelling ecosystem services (Pathak et al., 2019; Shukla et al., 2018).

Therefore, a significant problem in watershed management is the identification of project parameters with high stakeholder agreeability. This is imperative because, as conceived in IWRM and IWMP principles, any alternative decision should attract the participant CBOs (Carmona et al., 2013). However, the core of the difficulty lies in the abstractness of IWRM protocols, which makes 'IWRM an end in itself' (Giordano & Shah, 2014). Critically reevaluating IWRM, Biswas found that there are 35 sets of issues that different authors suggest should be integrated under IWRM. However, achieving integration for these issues is not feasible (Biswas, 2009). In this context, to address current and future challenges, the UN and OECD emphasise the need for clear public policies with measurable objectives, assigned responsibilities, and regular monitoring and evaluation (UNECE & OECD, 2017). FAO recommended conducting a multidisciplinary assessment of the watershed situation and trends to understand the main issues at stake, establish a baseline and adapt solutions to the local context (FAO, 2017).

Many research works and case studies were conducted to investigate the key parameters contributing to sustainable watershed programmes. Some pertinent literature is discussed below.

2.3.1 Variables related to the modern approach

The modern watershed approach emphasises multiple focuses, planning and assessment by stakeholders, evolving around livelihood, poverty and sustainability, participation of CBOs, focus on small watersheds, devolution of ownership to community, importance to common-law statutes and qualitative outputs with increase in production and conservation (FAO, 2017; Sreeja et al., 2015). The OECD report (1915) presented various aspects of water governance and has developed a set of principles on water governance on the premise that there is no one-size-fits-all solution to water challenges worldwide but a menu of options building on the diversity of legal, administrative and organisational systems within and across countries. The principles are rooted in the broader aspects of good governance: legitimacy, accountability, human rights, rule of law and inclusiveness. The OECD water governance principle 10 is relevant for framework development. (OECD, 2015).

Similarly, FAO observes that, *unlike sectoral development approaches, watershed management involves examining the interactions among various natural processes and land uses and managing land, water and the broader ecosystem of the watershed in an integrated way. It combines measures that improve or conserve the ecosystem services and functions in the watershed (mainly those related to water), increase land productivity and resource efficiency, and improve or diversify people's livelihoods and income. By integrating these measures in a well-defined geographic space and time sequence, the approach is expected to deliver multiple benefits, both on and off-site and in the short and long term* (FAO, 2017).

Based on these observations, different variables for sustainable watershed programmes can be incorporated into the evaluation framework, as discussed below.

2.3.2 Variables related to watershed inventory

Any watershed evaluation framework modelling building block should be built on watershed inventories and screening of management alternatives and outputs (Heathcote, 2009). In this light, this study may include these watershed inventories: a) Use impairment and water conflicts, b) Hydrology, biology and water quality, c) Land use and vegetative practices, and d) Facilities and infrastructure. These should be looked through in scope: a) critical problems, b) indicators of progress, c) planning constraints, and d) evaluation criteria. Contextually, Heathcote further referred to some crucial watershed inventory study tools:

1. A foundation map of the selected watershed, preferably showing a) Topography, b) Location of significant features such as dams, protected areas, areas of cultural values, habitats of

species, c) Overview of land use (open space, forested, agricultural, restricted, d) Location of sources, e) Spatial relationship between sources and receiving waters, f) Political boundaries.

2. Data collected from field studies and state agencies on components' physical, biological, and chemical characteristics.

3. Public commentary about the basin's critical water use impairment and use conflicts.

2.3.3 Variables related to structural components

One of the most common practices undertaken in watershed management is structural measures (structures and other built technologies). Structural measures are used when there is the possibility of creating something, such as a treatment plant, stormwater detention pond, or check dam for flood improvement goals. Such goals for the framework are extracted from watershed project documents (SLNA 2010a; b; c, 2011; State Level Nodal Agency Assam, 2019).

2.3.4 Variables related to naturalisation measures

River basins as units of Natural Resource Management (NRM) have found renewed acceptance since the early 1990s in the form of Integrated River Basin Management (IRBM) and Integrated Water Resources Management (IWRM) (Sreeja et al., 2015). The naturalisation measures are specialised measures to improve watershed activities wherein removal of dam and weir to facilitate fish passage and improved aquatic habitat, naturalisation of stream channels is aimed at. Such measures like restoration of degraded ecosystems, conservation and distribution of rain and groundwater, and afforestation obtained from project documents are incorporated into the variable list of this study.

2.3.5 Variables related to non-structural components

Heathcote elaborated that vegetative practices (a non-structural measure) may include activities that change the extent, nature and timing of vegetation cover and the rate and quality of water flowing over the land surface (Heathcote, 2009). Such actions are essential as farm operators can readily control them and are often low in cost to provide secondary benefits in terms of crop production.

Another non-structural management option is best management practices. It is different from best management technology and is said to be more effective than structural measures (Heathcote, 2009). The best management practices in the agricultural system may include contour ploughing, crop rotation, and high-yielding varieties. Although these measures are low-cost and practical, they are still more complex to implement as they require a change in the mindset of the farmers. Sometimes special grants, loans and tax relief can help encourage a shift (State Level Nodal Agency Assam, 2019). This study includes various best management practices as performance indicators in the production and economic activity sector.

2.3.6 Variables related to organisational planning

The backbone of adaptive watershed management is the community groups. In this approach, social, structural, physical and environmental inequities should be tackled through the active involvement of community members and organisational representatives (National Rainfed Authority, Government of India, (2011). So, there should be proper due diligence in the formation of CBOs. Water managers continually strive for good participation, alertness and willingness to work from CBOs. Including members from different community sections and providing representation from reserved communities and women are essential from socio-psychological points for successful community engagement (NITI Aayog, 2019).

Usually, the bureaucratic and technocratic group recommends and approves the watershed plan, and strategy suitability is determined by an elected body, such as a regional or local government or a state (Carmona et al., 2013). By the IWMP protocols, these plans should reflect most of the community's interests. Therefore, trade-offs must be made when selecting the final plan. Heathcote contextualised several elements for successful watershed policy implementation (Heathcote, 2009). Some of them are *Engaging a single lead agency with a simplified structure, strong linkage to existing programmes, clear designation of responsibilities and timetables, effective laws and policies, tracking of the degree of implementation, monitoring and reporting of progress to sustain public and political interest and enthusiasm, ongoing public education to enhance social consensus and adequate funding*. Leach suggested these seven normative ideals applicable in any public partnership for watershed management: Inclusiveness, representativeness, Impartiality, Transparency, Deliberativeness, Lawfulness and Empowerment (Leach, 2006). Following this literature, some organisational planning variables are included in the evaluation framework.

2.3.7 Variables related to developmental criteria

The watershed ecosystem and the human, social and economic systems in a watershed are dynamic and never static. Subsequently, the fundamental principles of water administration must move through many knowledge coordination stages. Therefore, watershed management should focus on developmental issues, including training, feedback, and evaluation procedures. (Conservation Ontario, 2010; FAO, 2017; Gaur & Milne, 2015).

Goodman and Edwards set two goals for integrated water planning and management, namely, (a) to plan programmes that are economically efficient and socially desirable and (b) to make them sustainable for a more extended period (Goodman & Edwards, 1992). Heathcote suggested the following developmental goals to be incorporated into adaptive watershed management: i) Maintenance of environmental quality, ii) Utilisation of resources with technical and economic efficiency, iii) Creation of incentives to encourage political and economic stability, iv) Maintenance of future options, v) Controlling population migration and generation of equivalent opportunities for all, vi) Increasing value of national capital, vii) Using renewable resources to create additional demands, viii) Equitable redistribution of wealth to the poorer community with the assistance of the wealthy (Heathcote, 2009). Similarly, FAO stressed that in selecting watersheds, criteria such as representativeness, visibility and accessibility; evidence of watershed degradation and physical restoration potential; diversity in land-use pattern, products and problems to be addressed; demonstrated interest of stakeholders; showed commitment and support from government line agencies and local entities; and the need for protection of high-value areas downstream are essential (FAO, 2017).

Converging on the consensus of the researchers, in this study, the criteria of evaluations are chosen with utmost care to include the priorities set by stakeholders. A list of 227 watershed performance variables (clustered into 31 sub-areas or sub-domains and eight operational areas or domains) is prepared as referred to in Chapter Three.

2.4 Watershed community-based organisational structure and identifying community participation variables for effective engagement

One objective of this study is to develop and validate a community participation evaluation framework (CPEF) and community participation index (CPI) for evaluating the degree of effectiveness of the community participation mechanism adopted by watershed managers. Different literature is reviewed for micro-level understanding of the forms of participation, community participation domains and variables and for providing a means to measure participation.

2.4.1 Engagement of the community in the watershed programme

Identifying critical management actions is very challenging when dealing with the complex economic-social-institutional-environmental systems in which the IWMP operates. Moreover, watershed managers should periodically customise the IWMP-CMAs for dynamic capacity development of the river basin organisations to minimise the negative impacts, maximising development partners' benefits. For this reason, some researchers are also critical of the success of multidimensional frameworks, observing that these are often hard to implement and may not address conflicting perspectives or subjective elements (Lemos and Farias De Oliveira, 2004; Span et al., 2012).

A comprehensive study for a watershed project should address all the factors related to all the dimensions viewed from stakeholders' perspectives, and any framework should be implementable only if it is socially and environmentally resilient. This is because a critical component of successful public participation in watershed planning and management is demonstrating to stakeholders that "there is something in it for them." (Smith, 2002). The technical advisory committee on GWP emphasises that in an enabling environment, all stakeholders are to be enabled to play respective roles in the "rules of the game" (Technical Advisory Committee, 2000). Expressing that water governance is more than fixing the water policy; the UN report emphasises that management is about exercising power in policy-making and whether or not to implement particular policies. The report asserts these pertinent questions: *"Which actors influenced the policy? Was the approach developed in a participatory and transparent fashion? Can revenues and public and bureaucratic support be raised to implement the policy"* (United Nations, 2015)? The OECD Report 2015 acknowledges that identifying relevant water resource problems and solutions is essential. However, to achieve viable policy responses, the report raises important questions about who should take action, why, at what government level, and how (OECD, 2015). Considering all these issues, examining the effectiveness of watershed community participation programmes may be valuable. Besides, coherent policy responses with stakeholder engagement, regulatory frameworks, information availability, capacity, integrity, and transparency are crucial (Akhmouch & Correia, 2016).

2.4.2 CPEF Variable Identification

Many authors and policy-makers analysed the forces affecting water management to suggest various indicators for sustainable development through watershed programmes

(Hooper, 2006; Akhmouch & Clavreul, 2016; Bertule et al., 2017; Jensen & Wu, 2018; Geressu et al., 2020). Investigating the assessment of watershed effectiveness, Douglas Kenney observed that, although examining *"keys to success"* and *"lessons learned"* is valuable, it is somewhat limiting if the real goal is to evaluate the overall effectiveness of watershed initiatives (Kenney, 2000). He suggested that success can be measured by *"organisational and process outcomes" related to group formation, dispute resolution, trust building, etc. This definition also can rely on "activity measures" such as plan development or public education requiring that watershed initiatives be judged according to their success in achieving on-the-ground outcomes."* (Kenney, 2000).

Regarding appropriate indicator development, Adam and Hess (2005) emphasised adopting indicators with subtle value to build a bridge between the theoretical abstractions and the practical reality (really knowing what a particular community wants/needs). Indicators should create metaphors and images that might help illuminate the complexity of community engagement issues (Adams D. & Hess M., 2005).

2.4.3 Critical domains of community participation mechanism (CPM) in watershed project

Practically, watershed practitioners must define the most effective community participation actions or practices to encourage the community's involvement toward the project goals. He should also be aware that these actions will be the independent variables in their community participation mechanism (CPM) influencing the project outcome (dependent variable). The next question is: What are the critical domains and variables of the CPM?

A large number of researchers have worked on a multidimensional watershed success evaluation framework (Kenney, 2000; Smith, 2002; Hooper, 2010; Sood & Ritter, 2011; Sreeja et al., 2015; Yavuz, 2018; Sriyana et al., 2020). Heathcote recommended water management impact evaluation considering the comprehensive evaluation of potential impacts on the social, cultural, economic and biophysical environment, including preventive or corrective measures (Heathcote, 2009). For this study, a list of potential watershed strategies presented by Heathcote is adopted as a basis for listing ideal actions on watershed inventories since it categorises the variables systematically. Notably, Hooper B (Hooper B., 2010) reported the development of 115 indicators of best practices in river basin management. These indicators were grouped into ten categories: "*coordinated decision-making, responsive decision-making, goals and goal shift, financial sustainability, organisational design, the role of law, training and capacity building, information and research, accountability and monitoring, and private and public sector roles*." Subsequently, using 63 performance indicators, Hooper developed a self-assessment tool for performance evaluation for the Delaware River Basin Commission. Studying Public Private Partnership projects, Ozdoganm and Birgonul divided the success factors into four main groups: i) Financial, ii) Political and Legal, iii) Technical, and iv) Social (Ozdoganm & Talat Birgonul, 2000). In this grouping method, Ng S. et al. have added another factor related to staff issues and success factors (Ng et al., 2012).

A similar grouping method is adopted for this study, accommodating idealistic watershed doctrines to frame the domains in the CPEF. A literature summary on variable identification for different watershed domains is presented below.

2.4.3.1 Determining Variables under the Socio-cultural Domain

Watershed policy-makers and managers should focus on the project's impact on the community's socio-cultural aspects. A big question arises: Does participation lead to the empowerment of marginalised groups—does it lessen exclusion, increase the capacity for collective action, or reduce the possibility that locally powerful elites will capture project benefits? (Mansuri et al., 2004) . Oza emphasised that institutions excluding women from the decision-making process do not represent the ground reality, and consequently, they do not run systems efficiently or equitably (Oza, 2007). Gender Equality comes under United Nations Agenda 2030 Sustainable Development Goals (SDGs) Goal 5 (The United Nations, 2023).

Based on the above literature, the Socio-cultural domain should include variables like value addition to socio-cultural cohesion, equitable service delivery, scope of job opportunity, rehabilitation and compensation policies, social return on investment, acceptability of tariffs/levies, and effect on population mobility.

2.4.3.2 Determining Variables under the Legal Institutional Domain

In every society, conflict may arise, and these must be resolved smoothly by running social endeavours. These resolutions should be within the boundaries of acceptable societal behaviours to specify sanctions and penalties. In watershed operations, legal factors are primarily influential for resolving conflicts smoothly within the boundaries of sanctioned social behaviours. The water law systems should acknowledge the social and environmental dimensions through norms intended to protect third parties, the environment, and the resource base (Solanes & Gonzalez-Villarreal, 1999). Regarding water and environmental management practised in the USA and Canada, Heathcote noted an essential point: numerous common law rights and responsibilities exist besides statutory or written laws. The most common are nuisance, riparian rights, strict liability, trespass and negligence (Heathcote, 2009). Contrarily, the legal system in India is mainly based on written law or statutes. Still, a more extensive scope of common law rights and responsibilities is enforceable through local government and CBOs. Specific and socially adaptable water rights and laws will enforce the policies and educate and encourage the community for a better future.

So, this domain also includes factors like mode of transfer or devolution and authority sharing, contract flexibility among the stakeholders like legality and flexibility of service/ supply/pricing, compatibility of rules with statutes and institutional development, scope of dispute management, land tenure policy, government support to regulations, and resilience to political sensitivity.

2.4.3.3 Determining Variables under the Organisational Domain

Usually, policy-makers have specific guidelines about appropriate organisational actions in a watershed project. In India, the NITI Aayog and government departments (DoLR and SLNA) issue standard guidelines emphasising meaningful collaboration of community-based organisations (CBO) with the programme. So, each of them should have a proper role and risk allocation (SLNA 2011; Smyle, 2014a; NITI Aayog, 2019). The variables in this domain should include fixing the number and attributes of the community participants in each CBO, defining their roles and transparent role allocation, hierarchy and inter-relationships, coordination and training.

2.4.3.4 Determining Variables under the Developmental Domain

Post-project monitoring and follow-up are essential components of IWMP management. Reliable monitoring and follow-up systems help determine compliance, identify any unforeseen effects, and determine the effectiveness of mitigation measures. Planners' awareness of building societal resilience and protecting economic growth in future uncertainties is indispensable. So, the CPEF should incorporate critical actions for a resilient watershed programme. For resilience against political and institutional instability, Hurford et al. endorsed transferring the skills acquired to improve institutional competence (Hurford et al., 2017). Such skill transfer stimulates the process of social learning. Social learning in river basin management refers to developing and sustaining the capacity of participant authorities, experts, interest groups and the public to manage collectively (Koontz, 2014; Pahl-Wostl et al., 2008). To avoid the deep uncertainties of social behaviour and exogenous events, Walker et al. (Walker et al., 2015) suggested incorporating flexibility and learning mechanisms in water management. Watershed managers are responsible for ensuring that the enabling conditions for social learning are accessible (Wehn et al., 2018). Considering all these perspectives, the CMAs for the developmental domain are formulated from literature (Grimble, 1998; Borisova et al., 2012; Prell et al., 2016; Akhmouch & Clavreul, 2017; Barbosa et al., 2017; Wehn et al., 2018).

2.4.3.5 Determining Variables under the Environmental Domain

The impact of human endeavours on the environment and its assessment is essential. Sadler noted that environmental assessment (EA) has been called one of the more successful policy innovations of the 20th century (Sadler et al., 1996). Heathcote also noted that, in EA, projects are to be evaluated in the light of i) clearly stated goals, ii) Adequate consideration of alternatives, and iii) Comprehensive evaluation of potential impacts on the social, cultural, economic and biophysical environment. iv) Preventive or mitigative measures (Heathcote, 2009). Strategic Environmental Assessment (SEA) is compulsory for major public projects in Canada, New Zealand, the EU, and Australia. The Ontario Environmental Assessment Act (1990) is one of the most comprehensive statutes (Conservation Ontario, 2010; Government of Ontario, 2020; Mitchell et al., 2014). This act has defined the environment to include: a) Physical features (land, air, water), b) Devices and things made by man (buildings, structures, machines), c) Any solids, liquid, gas, odour, sound, vibration, radiation), d) Biological subjects (plants, animals, man), e) Human and ecological systems (social, economic, cultural conditions).

2.4.3.6 Determining Variables under the Technical Domain

In a watershed project, the facilities provided to the producers and users should be technically viable and manageable by the users (Smyle, 2014a; FAO, 2017; NITI Aayog, 2019). Some critical technical factors related to services, like differential delivery, measurability, scheduling and upgradability, were explored by Ng et al. (2012). They are also crucial for IWMP service delivery.

2.4.3.7 Determining Variables under the Financial Domain

As financial appeal is a strong determinant to generating better community participation, all project managers must implement appropriate financial management actions and make the community aware of their values. From this perspective, CMAs for the CPEF can be framed from watershed literature and guidelines (OECD, 2001; Chopra et al., 2002; Sreedevi et al., 2008; SLNA 2010a, 2014b).

2.4.3.8 Determining Variables under Economic Domain

Overall, economic advantage is a precondition for a watershed project. Therefore, managers must initiate critical management actions, from planning to auditing. Heathcote documented many essential and everyday watershed management economic actions (Heathcote, 2009; Smyle, 2014a) that can be adapted to the CPEF.

2.5 Mapping watershed project performance variables based on local watershed projects' goals and achievements viewed from community perspectives.

2.5.1 Important features of performance evaluation

This study aims to develop and validate a community-centric watershed performance index (PI) for evaluating project performance. A detailed literature study is undertaken to take ideas from the fundamental theories and components of adaptive watershed management. Then, the detailed project report of three IWMP projects in Assam, India, is reviewed to obtain one set of performance evaluation variables for each project.

There is no one-size-fits-all solution to water challenges worldwide, as there is a large diversity of situations within and across countries. So, water governance is highly context-dependent, and responses should be adapted to territorial specificities (OECD, 2015). In this regard, some inherent challenges to watershed managers include identifying the appropriate scale for interventions and delineating boundaries; selecting technical and methodological elements to define what constitutes integration; handling uncertainties that iterative negotiation processes among stakeholders may bring about; and measuring multiple benefits and impacts (FAO, 2017).

For this reason, watershed planning and evaluation is necessary at the national, subnational and local levels. Efficient institutions are essential to accommodate cross-sectoral collaboration for the sustainable management of natural resources and to facilitate adoption and uptake by local stakeholders through national programmes. Different responsibilities of government authorities are incorporating and institutionalising successfully tested practices, approaches and collaboration models in national policies, adopting a country-wide investment framework, strategies and programmes for watershed management to achieve transformational change in the long run (Liniger & Studer, 2017). The local level of watershed planning necessitates more detailed region-specific perspectives. At this level, watershed project planning should be less abstract and more strategic for direct impact, and project goals are to be clearly defined, preferably with community involvement. This is because local participation is proposed to achieve various goals, including sharpening poverty targeting, improving service delivery, expanding livelihood opportunities, and strengthening demand for good governance (Mansuri et al., 2004). Scientific methods enable the assessment of off-site effects of these goals and design management strategies to take all local aspects of the soil-vegetation-water-climate interdependencies into account.

Integrated Water Resource Management (IWRM) is a worldwide accepted policy objective. In India, the National Institution for Transforming India (NITI Aayog), the Ministry of Department of Land Reforms, and the Ministry of Water Resources have emphasised the Integrated Watershed Management Programme (IWMP) through stakeholders' participation to achieve sustainable economic growth (National Rainfed Area Authority, 2011). Despite the high acceptance of IWRM and IWMP principles, the variables for performance evaluation of IWMP projects are relatively amorphous as the project goals are specific to the regional hydrological and social characteristics. This makes IWRM operations exceedingly challenging to comprehend. Subsequently, the NITI Aayog has developed the Composite Water Management Index (CWMI), incorporating nine themes and 28 critical indices for different areas (NITI Aayog, 2019). CWMI report provides an annual snapshot of the water sector status and the water management performance of the other states and UTs in India. CWMI establishes a clear baseline and benchmark for state-level performance on the water indicators, encouraging states and non-profit organisations to highlight participatory governance practices (NITI Aayog, 2021). Accordingly, watershed projects strive to utilise and control water and allied resources in the project area through community-based organisations' (CBO) participation (Kumar et al., 2023). Therefore, it is imperative to evaluate the performance of individual watershed projects through a participatory mode.

A notable definition of success of a watershed programme is: A watershed initiative is successful if it contributes (or can be reasonably expected to contribute eventually), in whole or in part, to the achievement of on-the-ground natural resource objectives, defined by prevailing social norms and laws, beyond what would have occurred (or will likely occur) in the absence of the watershed initiative (Kenney, 2000). The goal of most public networks is to enhance community services. Andrews, Boyne, Law, and Walker (2009) examined the effectiveness of local governments and concluded that "local public networks aim to satisfy the demands of their citizens and therefore the degree to which these demands are met constitutes the most important performance indicator" (Andrews et al., 2009).

The World Bank has identified five critical areas of watershed improvement (Department of Land Resources, 2015; Borisova et al., 2012; Bruneau, 2005). (FAO, 2017; Gaur & Milne, 2015; Giordano & Shah, 2014; Integrated Water Resources Management (IWRM), 2013; United Nations, 2015).

Table 2.2: Adaptable approaches for CP-related areas

Areas to Improve	Relevant approaches
Planning	Participatory planning
Institutions and capacities	Developing capacities of CBOs and other stakeholders for improving governance
Equity and livelihoods	Developing an operational strategy for implementing equity concerns enhancing agricultural production, productivity, and livelihood opportunities are all critical actors in research, extension, business, and commerce.
Sustainability	Managing water demand and enhancing livelihood and productivity, best management practices, convergence of IWMP with other government schemes at the field level, facilitating private sector participation
Monitoring and transparency	Testing and integrating improved performance benchmarks, supporting periodic performance-related action research, Involving communities in local monitoring,

2.5.2 Performance Domains and Variables in IWMP Projects

Viewing watershed management as a platform for poverty alleviation, the Government of India (GoI) formulated a standard guideline for Watershed Development in 2008 (National Rainfed Authority, (2011), with nine key features: *i) Delegating power to the state, ii) Dedicated institutions, iii) Financial assistance to dedicated institutions, iv) Longer duration of the programme (through three distinct phases, namely, preparatory, works and consolidation phase), v) Livelihood orientation, vi) Cluster approach, vii) Scientific planning, viii) Capacity building of stakeholders, ix) Multi-tier approach*. The common guidelines are based on seven principles: *i) Equity and gender sensitivity, ii) Decentralisation, iii) Facilitating agencies, iv) Centrality of community participation, v) Capacity building and technology input, vi) Monitoring, evaluation and learning, vii) Organisational restructuring*.

The NITI Aayog (India) has developed a Composite Water Management Index (CWMI) to assess and further improve the performance in the efficient management of water resources (NITI Aayog, 2019). The Aayog suggests that *"The index would provide useful information for* *the States and the concerned Central Ministries/Departments, enabling them to formulate and implement suitable strategies for better management of water resources"*. The index incorporates 28 critical indicators in different areas, including watershed management. The indicators are focal points about which assessment procedures for participatory appraisal can be designed by watershed managers. The CWMI 2019 measures the performance of States on a comprehensive set of water indicators and reports relative performance in 2017-18 as well as trends from previous years (2015-16 & 2016-17). Such a benchmarking exercise can go a long way in creating a common frame for water progress in India and highlighting the need for specific improvements (NITI Aayog, 2019).

The Department of Land Resources Ministry of Rural Development (DoLMRD, GoI), working in association with the World Bank, has stressed that although a watershed is a geo-hydrological unit, it is more a socio-technical system, since people reside in a watershed and, therefore, *"IWMP is more diverse and socially inclusive as compared to the previous watershed programmes"* (Department of Land Resources Ministry of Rural Development, Government of India, 2021)

Indian water management policy and approach are documented in the guidelines and directives of NITI Aayog (NITI Aayog, 2017) and SLNA objectives from detailed project reports of different projects in Assam (SLNA 2010a; b; c, 2011; State Level Nodal Agency Assam, 2019).

An empirical understanding of IWMP reveals that a watershed project is a means to an end rather than an end, with two broad primary aims: i) reduce poverty and strengthen social equity and ii) provide environmental protection and ecosystem services. Reducing poverty through water management is a practical pro-poor framework for action, allowing for the introduction of inter-related issues of governance, water quality, access, livelihood opportunities, capacity-building and empowerment, water-related disaster prevention and management, and ecosystem management (United Nations, 2015). The interrelated sectors under IWMP are classified as i) Natural Resource Management, ii) Production systems and iii) Livelihoods for the asset-less.

Along with these, capacity building and institution building, M&E, convergence, etc, are expected to go hand in hand (State Level Nodal Agency Assam, 2019). Regarding assessment, DoLRMRD further suggested incorporating the benchmarks identified by the NITI Aayog into the DPR with a project-specific baseline that helps capture the achievement of the targets. There is also a well-designed MIS plan for tracking the actions undertaken in watershed projects in different states and districts to strengthen and assess watershed performance and participation.

After reviewing the literature and project documents, it is felt that an analysis of the effects of participation on the quality-of-service provision is yet to be done. It necessitates a method for measuring and comparing outcomes, as well as for measuring participation, where this is quantitatively achievable and expressive. Besides, the impact of a watershed programme should be assessed by comparing performance against some planned objectives through a participatory approach to improve service delivery.

2.6 Evaluation of functional involvement and managerial effectiveness of participant watershed organisations

2.6.1 Central principles of watershed governance

One fundamental precept of IWRM and IWMP is creating CBOs and involving democratically elected peoples' representatives in the development and management system. The underlying principle of this approach is the supplementation of traditional top-down strategies with bottom-up strategies to make the watershed sector demand-driven. This will deliver welfare gains to the whole range of end-users and local producers. Indian watershed policy asserts that projects should facilitate peoples' responsibility for resolving demands side management as they learn to own the project in the interest of long-term sustainability (State Level Nodal Agency, Assam 2010c).

Here, some basic questions arise: Does the present organisational structure generate community involvement as expected? Are essential managerial functions shared with the participant organisations for proper devolution of responsibilities and rights?

Reviewing a broad array of literature to answer this question: 'What is the central value around which watershed organisation's function?' — it is understood that a proper organisational management policy is vital to watershed projects. Technical Advisory Committee of Global Water Partnership (TACGWP) observes that flawed demarcation of responsibilities between actors, inadequate co-ordination mechanisms, jurisdictional gaps or overlaps, and the failure to match responsibilities, authority and capacities for action are all significant sources of difficulty with implementing. The committee further asserts, '*Organisational development is not simply about creating formally constituted organisations (e.g. service agencies, authorities or consultative committees). It also involves consideration of a whole range of formal rules and regulations, customs and practices, ideas and information, and interest or community group networks, which together provide the institutional framework or context within which water management actors and other decision-makers operate*' (Technical Advisory Committee, 2000). UN World Water Dev Report 2002 observes that '*governance addresses the relationship between organisations and social groups involved in water decision-making, both horizontally, across sectors, between urban and rural areas, and vertically, from local to international levels. Operating principles include downward and upward accountability, transparency, participation, equity, rule of law, ethics and responsiveness*' (United Nations, 2015).

In the opinion of the Food and Agricultural Organisation, '*the fundamental principles for enhancing effective governance should include participation, accountability, transparency, equality and fairness, efficiency and effectiveness, and the rule of law*' (FAO, 2013b). Notably, the OECD principle has incorporated some essential managerial functions of water management organisations. (OECD, 2015).

The generation of coordinated management necessitates an inclusive organisational structure. The concept of 'inclusive governance' (IG) has recently appeared in international cooperation circles. Its emergence is closely linked to the Agenda 2030 and particularly Sustainable Development Goals 16 (United Nations, 2023). The core distinctive feature is the addition of 'inclusion' as a normative benchmark — premised on the assumption that inclusive societies and institutions tend to be more prosperous, effective and resilient in the long run (European Centre for Development Policy Management, 2021).

IG is particularly relevant for watershed management, where numerous agents of change and multiple drivers exist. The experience emerging from the study is that better results are generated when watershed policies clearly define the functions and roles of the component organisations and give the latter considerable autonomy while effectively holding these units accountable for performance. Separation of functions and responsibilities, in terms of roles, functions and authority levels, with appropriate mechanisms for linkages and coordination, helps speed up decision-making, increases overall accountability and improves performance. In a participatory approach to inter-organisational conflict resolution, a little autonomy and guidance given at all hierarchy levels and decision-making will lead to better performance and satisfaction (Michael Fonceca et al., 2017).

2.6.2 Some governance problems

To achieve effective governance of water resources and services, decision-makers and service providers need to take responsibility for their decisions and the quality of service. Accountability mechanisms can clarify the commitments of actors involved in water governance and lead to efficient management of fiscal resources. Besides, it protects water resources and increases control over the actions of public and private stakeholders while ensuring adequate quality standards.

The UN observes that applying the Integrated Water Resources Management (IWRM) concept has yielded uneven results within and across countries, necessitating an adaptive operationalisation framework. While many countries face stalled water reform, others have made great strides in implementing various aspects of integrated water resources management (IWRM), including decentralised management and the creation of river basin organisations (United Nations, 2015). Consequently, there is no universal best way to govern watershed organisations. The literature is inconclusive about the variables that predict network effectiveness (Span et al., 2012). Therefore, contingency factors are likely to have a significant impact on the performance of the networks. Insight into governance roles within a network and the effectiveness of these roles can support local managers and policymakers in determining their choice of governance (Span et al., 2012).

2.6.3 Evaluation of managerial effectiveness of project-level watershed organisations

In a collaborative organisational structure, as in the watershed programmes, the managers should be sure about their authority over their subordinates and, simultaneously, be aware of the authority sharing between different collaborating units. Watershed managers need to explain clearly and instruct the participating organisations concerning their areas of responsibility and share managerial functions to carry out.

Appropriate theoretical-based methods for assessing governance networks were sought in the literature; the field is incomplete and highly fragmented. Existing assessments of water resources are often inadequate for addressing modern water demands (Alvarado & Bornstein, 2018). This situation demands a closer look at the related development in management science. Literature shows that managerial effectiveness is a growing field of study and is difficult to define and measure. However, as watershed management calls for a collaborative workspace, assessing organisational effectiveness is vital. Such assessments reflect the shortcomings of managerial effectiveness and appraise the dimensions where managers are lacking or showing weaknesses. This, in turn, improves the effectiveness of the organisation. Assessments are also necessary to make informed investment and management decisions, facilitate cross-sector decision-making, and address compromises and trade-offs between stakeholder groups (Michael Fonceca et al., 2017).

Another conflicting term that crops up while looking at the dimensions of managerial effectiveness is managerial efficiency. It should be clear that managerial effectiveness and managerial efficiency are different. Sometimes, a manager or an organisation may be very efficient but ineffective. Fonceca et al. noted some qualities of effective managers or organisations as shown below: a) Doing the Right Things, b) Creating Productive Alternatives, c) Optimizing resource Utilization, d) Obtaining Results, e) Practicing Managerial Effectiveness (Michael Fonceca et al., 2017).

In this context, the question arises: What are the necessary managerial functions to be carried out by the project-level organisations based on which we can determine whether they are doing the right thing?

Going through the management science literature, the answer to the question might be given by management theories. In the early part of the twentieth century, French Industrialist

Henry Fayol mentioned five essential management function categories: Planning, Organising, Commanding, Coordinating, and Controlling (Hannan et al., 2003). By the functional approach, the answer to this question is that managers plan, organise, lead and control (Robbins, 2013). Management principles have long been categorised into these four primary functions and are widely recognised as the P-O-L-C framework. Lamond observed that the P-O-L-C functions of management still provide a handy way of classifying managers' activities to achieve organisational goals (Lamond, 2004). Since IWMP focuses on people's participation in watershed management, a maximum number of organisations should be allotted essential management functions.

2.7 Metric development: Aggregating sub-indices for developing Integrated Watershed Index (IWI)

This section presents the literature review on the importance and methods of aggregation of indices related to different watershed project phases.

The underlying principle behind the integrated water management process is Adaptive Environmental Management, which is the continuous and cyclical process of carrying out a plan that addresses identified issues and concerns that is then implemented, monitored, reported on and updated as required to adapt to changing or new emerging stressors (Conservation Ontario, 2010). Similarly, the "water-energy-food nexus" approach emerged in the late 2000s to frame cross-sector and cross-scale interactions in a context marked by growing concerns about the global economic and food security crisis (Middleton et al., 2015).

Against this backdrop, scientific methods of integrated modelling and assessment would enable researchers to live up to the challenge of the multi-dimensional character of land management (multi-functional, multi-scale, multi-time, multi-sectorial, multi-tenurial and multi-stakeholder). They should be based on systematically collecting and analysing data from natural sciences, social sciences and humanities. Interdependencies causing synergies and trade-offs of management practices within the complex soil-vegetation-water-climate nexus must be considered across different space and time scales. This is a pre-condition for developing solutions and recommendations that are more robust and sustainable than developing singular measures within one sector and focusing on one problem (Liniger & Studer, 2017).

Therefore, the central task for watershed management research is to define and measure the sources of service improvement. Research efforts increasingly focus on this complex topic and examine variables including organisational structure, goal ambiguity and networking (Andrews et al., 2009). The second significant task here is the aggregation of sub-indices to present the combined impact from all the related areas.

Now, a question arises: What kind of means is adaptable to reflect the central tendency or, so to say, an aggregated effect of different sub-indices?

To provide information to development agencies and others studying food, energy, and water resources, the RAND Corporation developed a global Pardee RAND Food-Energy-Water Security Index (FEW Index). The FEW Index comprises three sub-indices—one for food, energy, and water—and combines these sub-indices using an unweighted geometric mean (Willis et al., 2016). Another question may arise about the preference for Geometric Mean (G.M.) against Arithmetic Mean (A.M.).

The arithmetic mean is the sum of the values divided by the total number of values (i.e. the average of the values). On the other hand, the geometric mean signifies the central tendency of a dataset by taking the product of the values raised to the multiplicative inverse of the total number of values (Clark-Carter, 2010). The difference between arithmetic and geometric mean is shown in Table 2.3.

Table 2.3: The difference between arithmetic and geometric mean

Arithmetic Mean (AM)	Geometric Mean (GM)
1. It is calculated by dividing the sum of data values by the number of data values.	1. It is calculated by raising the product of data values by the reciprocal number of data values.
2. For a given set of data values $x_1, x_2, x_3, ..., x_n$, the arithmetic mean = $(x_1 + x_2 + x_3 + ... + x_n) / n$.	2. For a given set of data values $x_1, x_2, x_3, ..., x_n$, the geometric mean = $(x_1 \cdot x_2 \cdot x_3 \cdot ... \cdot x_n)^{1/n}$.
3. AM ≥ GM always for any set of data values.	3. GM ≤ AM always for any set of data values.
4. It applies to both positive and negative values.	4. It applies only to positive values.
5. It is affected by outliers.	5. It is not much affected by outliers.
6. It is easy to use.	6. It is more complicated to use compared to AM.
7. It gives a good and accurate approximation when there is a slight variation in the data.	7. It gives a good and accurate approximation when there is much variation in the data.
8. It is mainly used in the fields of maths and statistics.	8. It is used chiefly in the field of finance.

2.8 Summary:

This chapter discusses the most pertinent issues related to the research objectives based on existing literature. Reviews are presented section-wise, and each section relates to one chapter (Except Section 2.5, which contains a review related to IWMP, Assam) in the following part of the thesis. The following chapter describes the development of the watershed project desirability index (WPDI), which is related to the project planning phase.

Chapter 3 Harmonising stakeholders' perspectives: a watershed project desirability index

3.1 Introduction

As discussed in the literature review (section 2.3), it is evident that synchronising the project parameters with stakeholders' prerequisites is challenging for watershed managers. The problem intensifies as the participants' interests change for various reasons, like socio-political, behavioural, and institutional change. Watershed policymakers must identify the most adaptive domains and sub-domains based on commonly accepted IWRM principles in congruence with regional settings. Misalignment of perception between stakeholder groups leads to project failure. Therefore, checking the stakeholders' desirability regarding the project parameters is essential for proper planning, intervention, and restructuring.

Pursuing the research objective 'developing and validating watershed project desirability index (WPDI) for evaluating stakeholders' appeal for watershed projects', the current chapter describes a methodology to examine watershed parameters' desirability for constructing a watershed project desirability index.

Several authors have studied the forces affecting water management to suggest various key watershed parameters, and there is a remarkable consensus among them (NITI Aayog, 2019; Lemos et al., 2016).

J. Gallego-Ayala and D. Juizo (Gallego-Ayala & Juízo, 2012) attempted to evaluate river basin organisation and differentiated the relative importance of various indicators. Lemos et al. emphasised the development of metrics for adaptive capacity and water security as support for decision-making. Still, they contested in terms of a) which indicators should be included and at what scale, b) how to measure them, c) how they provide feedback on each other and affect established institutions such as law and regulation, d) how actionable they are, and e) how well they represent the dynamic, non-stationary, and complex systems they seek to represent (Lemos et al., 2016). In a study to identify the factors influencing the success of public-private partnerships, Ng S T et al. (2012) applied Spearman's rank correlation coefficient to calculate the aggregability of the stakeholders' groups.

However, little study has examined stakeholders' desirability about planned watershed indicators or assessed the degree of perception alignment amongst stakeholder groups. Therefore, it is imperative to explore how the disparity of perception can be measured to harmonise community participation.

Given that, this study focuses on these questions: Can there be some methods to select the most desirable watershed parameters from the stakeholders' perspective? Furthermore, can this methodology be used to construct a framework for determining the watershed project desirability index (WPDI), which is applicable as a decision-making tool in measuring watershed project effectiveness?

A comprehensive desirability study of a sustainable watershed project should begin with the most common parameters and management actions braced by socio-economic, environmental, and developmental dynamism as the effectiveness of an IWMP is reflected by the overall outcome in the watershed eco-system encompassing human, social and economic aspects (Kerr, 2007; Smyle et al., 2014). Then, based on the acceptability of the actors, a decision-processing indexing system might be formulated.

This study strives to answer a pertinent question for watershed project managers: How can we quantitatively examine the stakeholders' willingness to continue in the project? Subsequently, an indexing framework is developed to evaluate the alignment of stakeholders' perspectives regarding different project domains and sub-domains. The framework includes the most common watershed variables valid in a regional context. Therefore, it can be applied to similar projects in a homogeneous setting. Unlike the usually adopted top-down evaluation method, this study offers a participatory method using community information. The framework can potentially be used in IWMP projects, ex-ante or ex-post.

The methodology used to develop the desirability index of the watershed project is described in the following section.

3.2 Methods

3.2.1 Developing a hypothetical watershed parameters list

Firstly, a hypothetical, standard list of 227 critical parameters or indicators is developed by reviewing social science theories, research papers, IWRM books, OECD, and the World Bank guidelines for adaptive watershed management (NITI Aayog, 2011; NITI Aayog, 2019; Indicators and Benchmarks for Watershed Management Outcomes Institute of Rural Management Anand Department of Land Resources Ministry of Rural Development, Government of India and The World Bank, 2014; OECD, 2015; Conservation Ontario, 2010; Ehler, 2003; FAO, 2017; Heathcote, 2009; Hooper B., 2010; Hurford et al., 2017; Kerr, 2007; Kumar Shukla et al., 2018; NITI Aayog, 2019a; Pathak et al., 2019; Shukla et al., 2018, 2020; Smyle et al., 2014; Sreeja et al., 2015). Focusing on different perspectives of socio-hydrology, watershed management mechanisms, and possible economic and environmental impacts, the listed 227 parameters (Appendix A3.1: WPDI parameters list) are categorised into 31 sub-areas (Sub-domains) and eight operational areas (Domains) (Table 3.1).

Table 3.1: List of hypothetical domains and sub-domains for a watershed project

Domains	Sub-domains	Sub-domain Code
1. Land use and Morphology	Open Space Management	L1
	Plotted Land Management	L2
	Physical Land-Water Interactions	L3
2. Water and Uses	Water Quantity Management	W1
	Water Supply Management	W2
	Flood Management	W3
	Hydro-electric Power	W4
	Navigation Facility	W5

	Mining	W6
	Water-based Recreation	W7
	Water Quality Control -Physical	W8
	Water Quality Control -Biological	W9
	Water Quality Control -Chemical	W10
	Water Treatment	W11
3. Production and Economic Activities	Crop Management	P1
	Economic Audit	P2
	Livestock Management	P3
	Population Migration Control	P4
	Critical Planning (or budgeting) for Production Areas	P5
4. Forest and natural landscapes	Status Assessment and Planning	F1
5. Energy	Energy Alternatives and Conservation	E1
6. Socio-cultural Actions	Impact on Education	S1
	Social Impact	S2
	Community Inclusion	S3
7. Environmental Activities	Environmental Impact Assessment	V1
	Conservation and Awareness	V2
8. Development and Management	Goal Conformity	D1
	Role Articulation	D2
	Dynamic Assessment	D3
	Common-Law Causes of Action	D4
	Monitoring and Evaluation	D5

Secondly, an opinion survey was conducted with participants from two broad groups of stakeholders from the Satpokholi IWMP project in the Brahmaputra valley, Assam (India), to identify the most desirable watershed domains and sub-domains. A structured questionnaire based on a 5-point Likert Scale was used to collect their opinions on the hypothetical list. Then, applying relevant statistical analyses on the collected primary data, domains and sub-domains desirability and the degree of alignment of perceptions of the involved groups are tested. Finally, a watershed project desirability index (WPDI) was developed.

The validity of the WPDI is tested in two other watersheds in Brahmaputra Valley. Results show that this indexing method is appropriate for identifying a watershed project's most desirable watershed objectives and determining the desirability index of any operating project to enhance sustainability. Additionally, managers can compare the effectiveness of different functional watershed projects in an analogous environment by applying the indexing process.

3.2.2 Data Collection and Analysis

3.2.2.1 Data Collection

With the hypothetical list (Table 3.1), a pilot study was conducted before the data collection stage. Three experts with at least five years of experience in watershed projects representing the public sector, two from watershed monitoring agencies, and four beneficiaries were randomly selected from the general community to pilot the questionnaire (Appendix A3.2: Format of letters to experts/stakeholders).

A structured questionnaire protocol (Appendix A3.3: WPDI questionnaire sample) was designed based on identified parameters for field surveys. The study area, Satpokholi IWMP (3B1C8) project, is situated in the Brahmaputra valley in the Kamrup district of Assam (India). After an initial study of the project area and preliminary communication with the stakeholders, it was observed that there are noticeable differences in perception between the local stakeholders and the project experts. Subsequently, respondent stakeholders were classified into two groups using a stratified sampling approach (Table 3.2).

Table 3.2: Groups of survey respondents

Groups	Roles
Group 1	The watershed planners, academicians, consultants, water resource and IWMP officers in the public sector
Group 2	The IWMP CBO members, community beneficiaries, and volunteers at the field level

A total of 190 respondents took part out of 351 questionnaires administered, representing a response rate of 54.13%. The response rate of Group 1 is 58.3%, while that of Group 2 is 51.95%. Table 3.3 shows the breakdown of the survey sample.

Table 3.3: The response rate of the questionnaire survey

	Questionnaire Administered		Valid Questionnaire Response received		Response Rate %	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Sent by Hand/Post	120	231	70	120	58.3	51.95
Grand Total	351		190		54.13	
Sector-wise Percentage	34.19	65.81	36.84	63.15	19.94	34.19

Respondents were briefly introduced to the watershed concept and research objectives before distributing questionnaires. They rated the degree of importance of the identified parameters according to their desirability using a 5-point Likert scale.

3.2.2.2 Data Analysis Framework

The 5-point Likert scale rating was converted to an ordinal score for numerical analysis: strongly agree=5, agree=4, neutral=3, disagree=2, strongly disagree=1. Then, each group's mean score given to each parameter is calculated and summed up to obtain the mean score of each sub-domain. After that, the group-wise relative rankings of sub-domains and domains are determined in descending order of importance. A descriptive analysis was conducted to establish the relative significance of the parameters. Finally, the average rankings of the two surveyed groups are calculated to obtain the sub-domain and domain mean rank. This method facilitates cross-comparison of the relative significance of the domains and sub-domains across the respondents.

Spearman's rank correlation coefficient (Spearman's rho, ρ) reflects the level of agreements perceived by the groups on their rankings of domains and sub-domains (Equation 1) (Ng et al., 2012)

$$\rho = 1 - \frac{6\sum d^2}{N(N^2-1)} \qquad \textbf{(Eq.1)}$$

Here, d represents the difference in rank of the two groups for the same variable, and N denotes the number of pairs of variables ranked. The coefficient ranges between -1 and +1. A value of +1 represents a perfect positive linear correlation. In contrast, negative values indicate a negative linear correlation, meaning that the low ranking on one is associated with a high order on the other. If the correlation is close to zero, it implies that no linear relationship exists between the two variables. Thus, if rho is significant under the correlation test, one can reject the null hypothesis that there is no significant correlation between the two groups on the rankings. Generally, a rho value above or below 0.6 is standard. However, since watershed management includes macro-level accuracy, we have chosen this level to be 0.3 (in both +ve and –ve directions).

3.2.3 Testing the desirability of parameters

The terms, calculations, and arbitrary conditions for data analysis are shown in Table 3.4.

Table 3.4: Terms, definitions, calculations, and conditions employed in this study

Terms	Definitions	Calculations	Arbitrary conditions for desirability check (Assigned)
Domain	Watershed Project Operational Area		
Sub-domain	Watershed project sub-areas under the domains		
Desirability	The degree of appeal about a watershed domain about a domain or sub-domain		
Rank values (R1 for Group1 and R2 for Group2)	Rank values based on the average score obtained by each domain and sub-domain	Calculated in ascending order for the set of domains and sub-domains	
Mean Rank (MR)	Mean of inter-group rank value for each domain and sub-domain	MR= (R1+R2)/2 (Rank by Gr1plus Rank by Gr2 divided by Number of Respondent Groups)	
Threshold Mean Rank (TMR)	MR value limit to depict stakeholders' desirability about sub-domains	TMR=Maximum MR*(arbitrary percentage set by manager)	A sub-domain is desirable if its MR is below 85% of the maximum rank value (i.e. if MR<24.23) and if MRI>0.041; otherwise, undesirable
Mean Rank Inverse (MRI)	Multiplicative Reciprocal of MR value	MRI=1/MR	
Rho	Spearman's Rho value	By standard method	A parameter is desirable if Rho>0.3;
Threshold Rho (TR)	Arbitrarily chosen Rho value limit to depict		

	stakeholders' desirability about sub-domains		otherwise, undesirable
Validity Index (VI)	Validity of hypothetical list of parameters for the project.	VI= Numbers of desired sub-domains by TMR / Numbers of sub-domains listed.	VI<60% is not acceptable.
Effective Rank (ER)	Product of Rho and MRI for each sub-domain	ER=Rho * MRI	The ranking of the desired domain is in ascending order. Thus, the top-order sub-domain has a high rank.
Watershed Project Desirability Index (WPDI)	Product of the number of desirable sub-domains and summation of their ER (Rho*MRI)	= n*[Σ(Rho*MRI)] Where n denotes the number of sub-domains scoring above threshold rho and MRI values. (See example: Sub-domains in the HR-HM quadrant of Fig. 4)	It determines the total desirability of a watershed project.
Congruency of inter-group perception on sub-domains (CIP_{SD}) and domains (CIP_D)	Rho squared expressed in percentage	$= \rho^2 * 100\%$ Where ρ is the Spearman's rank correlation coefficient	If $\rho>0$, the CIP value indicates an alignment of perception; if $\rho<0$, it shows nonalignment. The maximum value of CIP_{SD} is 1, and acceptable CIP_{SD} >9% (since acceptable $\rho>0.3$)

Note: The table defines the self-developed terms used in this study and their calculation methods for the developed WPDI framework. For this framework, conditions and limiting values are assigned from a general perspective, as shown in the rightmost column. Policymakers and watershed managers can set suitable limiting values while using the framework in their projects.

3.2.4 Determining sub-domains desirability

The following methods are used to obtain the desirability of sub-domains.

3.2.4.1 Method-1 for Calculating Validity Index (VI) by sub-domains desirability with threshold mean rank (TMR)

The average score of both groups to each sub-domain is calculated from the primary data. Then, the average scores of each group are ranked in ascending order (from low to high value). After that, the mean of the inter-group rank value for each sub-domain is calculated. The mean rank value will indicate the comparative desirability of sub-domains. It will be the researcher's prejudice to assign an MR value level as threshold mean rank (TMR), below which value he will consider the sub-domain desirable. A manager can choose the TMR for the project under study. For example, if a watershed manager decides on sub-domains whose mean ranks are 85% of the maximum mean rank and the maximum MR is MRmax, then TMR= MRmax * 85%. The sub-domains having MR value below TMR are desirable.

This method is helpful as a validity test for the hypothetical parameters list. For example, a manager can find the validity index as VI = Numbers of desired sub-domains by TMR / Numbers of sub-domains. The watershed manager's prerogative will be to put a suitable value (say k) for desirable VI when VI<k is unacceptable. In this study, the k value is assumed to be 0.6.

3.2.4.2 Method-2 for Calculating Sub-domains Desirability by Threshold Mean Rank (TMR) and Threshold Rho (TR) Values

Method 2 is an improvement over Method 1. In Method 2, the effect of Congruency of inter-group agreement about each sub-domain is incorporated to make the desirability check more meaningful.

Spearman's rho (ρ) or Rank correlation coefficient indicates an alignment of inter-group agreement about a set of variables (parameters). The rho values may range from +1 to -1. +1 indicates a perfect association of ranks, 0 means no association, and -1 indicates a perfect negative association of ranks. The positive rho values indicate the favourable alignment of inter-group perception about a parameter set. Hence, one of the criteria for choosing desirable sub-domains can be filtering out the sub-domains with negative rhos. Thus, rhos are calculated on the stakeholders' groups' mean rank of each sub-domain parameter. However, sub-domain selection will be based on specific arbitrary desirability conditions or threshold rho values determined by the respective watershed manager. In this study, the threshold rho value is 0.3, meaning a sub-domain is desirable if rho>0.3; otherwise, it is undesirable.

The steps carried out for Method 2 are:

a) The inverse of mean rank (MRI) for all sub-domains (having an acceptable mean rank level) are calculated. Since the assumed TMR=24.23, the threshold MRI would equal 1/24.23 (or 0.041). Thus, the sub-domains with MRI values above 0.041 are considered desirable; otherwise, they are undesirable.

b) A threshold rho (TR) level is chosen. For this study, it is assumed to be 0.3. Sub-domains with rho values above 0.3 are desirable; otherwise, they are undesirable.

c) A decision matrix is constructed with the rationale presented in Table 3.5. This matrix is similar to the Importance-Performance Analysis (IPA) methodology, also known as quadrant analysis (Martilla & James, 1977). IPA is a helpful and straightforward technique for identifying attributes of a product or service that most need improvement or candidates for possible cost-saving conditions without significant detriment to overall quality. Practitioners apply IPA to analyse two dimensions of service attributes: performance level (satisfaction) and customer importance. Analyses of these attributes are then integrated into a matrix that helps a manager identify primary drivers of customer satisfaction and set improvement priorities based on these findings (Huang et al., 2015). IPA combines measurements of importance and satisfaction levels in a two-dimensional graph. Graphic IPA is divided into four quadrants based on the results of the Importance-Performance measurement (Fig. 3.1). This method depicts essential attributes along the X-axis and Performance attributes along the Y-axis (Shia et al., 2016). We have presented the rho value along the X-axis and the MRI value on the Y-axis.

Table 3.5: Decision matrix

Criteria/Quadrant	Rho Value	MRI	Decision	Rationale
HR-HM* Quadrant	High	High	Desirable	Stakeholders agree with a *desirable* mean rank
HR-LM* Quadrant	High	Low	Undesirable	Stakeholders agree with an *undesirable* mean rank
LR-HM* Quadrant	Low	High	Doubtful (Equally Probable) (Necessitates further inter-group consultation)	Stakeholders are not in *agreement* with a *desirable* mean rank.
LR-LM* Quadrant	Low	Low	Doubtful (Equally Probable) (Necessitates further inter-group consultation)	Stakeholders are not in *agreement* with *undesirable* mean rank.

Note: HR-HM represents high rho with a high mean rank, HR-LM represents high rho with a low mean rank, LR-HM represents low rho with a high mean rank, and LR-LM represents low rho with a low mean rank.

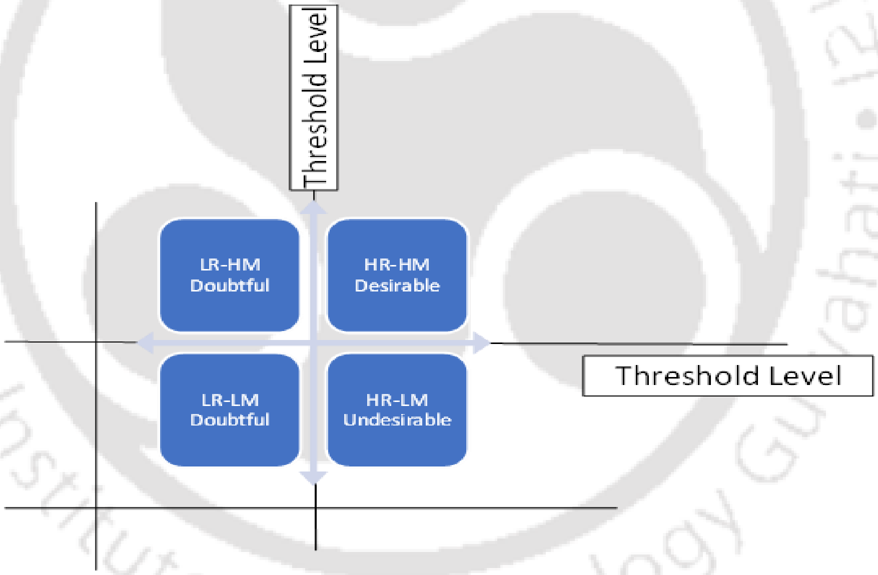


Fig. 3.1 Four quadrant decision graphic

3.2.4.3 Developing Watershed Project Desirability Index (WPDI)

The Rho*MRI value of a sub-domain is the product of the rho and the MRI value of the sub-domain. In Rho*MRI value, the rho value acts as a weightage that evolves from inter-group congruency of stakeholders' opinions. So, sub-domain desirability is a function of congruency and mean rank. Method 2 is an improvement on Method 1, where desirability is only calculated as a function of mean rank. Therefore, a sub-domain Rho*MRI value can also be termed an effective rank (ER). Subsequently, after getting the Rho*MRI score of each desirable sub-domain with high rho and high MRI (those appearing in the HR-HM quadrant), the desirability index of the watershed project can be calculated by the following formula,

Watershed Project Desirability Index (WPDI) = n*[Σ(Rho*MRI)]

Where n Number of Desirable Sub-domain above an arbitrary threshold level (Sub-domains falling on the HR-HM quadrant of Fig.2), and, [Σ(Rho*MRI)] = the sum of the product of rho and MRI of each desirable sub-domain.

In this index development, a question may arise about why we should have defined effective rank as (rho+MRI) using an 'OR' logic. If we use 'OR' logic, the rho value or the MRI alone can unilaterally influence the result. So, the result might be biased towards the enormous value. However, we require a method where rho and MRI are equally effective. Thus, we use 'AND logic' to define effective rank by Rho*MRI, where both scores influence the result simultaneously. As such, a high score of one cannot compensate for the low score of the other, and there is no trade-off on the lower score.

3.2.4.4 Congruency of inter-group perception on sub-domains (CIP_{SD})

Salkind suggested two methods for determining inter-group rank agreement (Salkind, 2017): a) by eyeballing the ρ value and b) by squaring the ρ value to reflect percentage agreement. Thus, when $\rho>0$, the ρ^2 value gives a percentage alignment of inter-group perception and when $\rho<0$, the ρ^2 value gives a percentage nonalignment of inter-group perception. Accordingly, CIP_{SD} is defined as $CIP_{SD} = \rho^2*100\%$.

3.2.5 Determining domains' desirability

The following methods are used to obtain the desirability of each domain (Table 3.7).

3.2.5.1 Domain desirability by domain MR

The average score given by both groups to each domain is calculated from the primary data. Then, the average scores of each group are ranked in ascending order (from low to high value). After that, the means of rank given to each domain is calculated. The MR score will indicate the comparative desirability of domains. No threshold value is used to find domain desirability.

3.2.5.2 Congruency of inter-group Perception on Domains (CIP_D)

Congruency of Inter-group Perception on Domains (CIP_D) is calculated by Spearman's rho (ρ_d) or Rank correlation coefficient for the domains. The CIP_D is defined as $CIP_D = \rho_d^2 * 100\%$.

3.3 Results and Discussion

Based on the WPDI framework and methodology, separate questionnaire surveys were carried out in three selected watershed projects (Satpokholi IWMP, Kaldia IWMP and Turkunijan IWMP). The results are validated by inviting six experts representing the participant groups for a focused group discussion.

3.3.1 Results and Discussion for Satpokholi IWMP

3.3.1.1 Calculating Validity Index (VI) and sub-domains desirability with threshold mean rank (TMR) (Method-1)

In the Satpokholi IWMP project, the sub-domains ranks given by two stakeholders' groups, and inter-group mean ranks are calculated (Table 3.6). The mean ranks of the sub-domains in ascending order are shown in Fig. 3.2.

Table 3.6: Sub-domain group rank and mean rank

Domains	Sub-domains with code	Sub-domain Rank Gr1	Sub-domain Rank Gr2	Mean Rank	Desirability by threshold MR*	Rhos	Congruency by threshold rho*	Overall sub-domain Rho on Rank Equivalent (ρ)
1. Land use and Morphology	L1 Open Space Management	24	10	17	D	0.716	C	0.117
	L2 Plotted Land Management	15	14	14.5	D	-0.487	NC	
	L3 Physical Land-Water Interactions and Prevention of Extreme Situations	10	6	8	D	0.184	NC	
2. Water and Uses	W1 Water Quantity	7	1	4	D	-0.66	NC	
	W2 Water Supply	23	5	14	D	0.099	NC	
	W3 Flood Management	1	2	1.5	D	-0.3	NC	
	W4 Hydroelectric Power	28	25	26.5	UD	0.5	C	
	W5 Navigation	25	26	25.5	UD	1	C	
	W6 Mining	30	24	27	UD	1	C	
	W7 Water-based Recreation	21	20	20.5	D	-0.187	NC	
	W8 Water Quality - Physical	1	29	15	D	-0.054	NC	
	W9 Water Quality - Biological	1	27	14	D	0	NC	
	W10 Water Quality -Chemical	15	31	23	D	0.395	C	
	W11 Water Treatment	1	28	14.5	D	0.5	C	
3. Production and Economic Activities	P1 Crop Production	9	9	9	D	0.252	NC	
	P2 Economic Audit	1	3	2	D	-0.333	NC	
	P3 Livestock	12	8	10	D	-0.15	NC	
	P4 Population Migration	31	7	19	D	-0.25	NC	
	P5 Critical Planning (or budgeting) for Production Areas	19	16	17.5	D	0.57	C	
4. Forest and natural landscapes	F1 Status Assessment	22	19	20.5	D	0.805	C	
5. Energy	E1 Awareness	25	23	24	D	0.632	C	

6. Socio-cultural Actions	S1 Impact on Education	29	13	21	D	0.5	C
	S2 Status of Community Actions	11	15	13	D	-0.232	NC
	S3 Community Engagement Assessment	20	4	12	D	0.359	C
7. Environmental Activities	V1 Impact Assessment	13	17	15	D	0.084	NC
	V2 Awareness Programme	1	21	11	D	-0.411	NC
8. Development and Management	D1 Goal Conformity	14	18	16	D	-0.2	NC
	D2 Role Articulation	7	12	9.5	D	-0.046	NC
	D3 Dynamic Assessment	18	22	20	D	-0.618	NC
	D4 Common Law Causes of Action	27	30	28.5	UD	0.82	C
	D5 Monitoring	17	11	14	D	0.114	NC
Total sub-domains	31						
Total desirable sub-domains by threshold mean rank	27						
Validity Index	= (27/31) *100%=87.1%						
Total sub-domains with aligned opinions (with +ve rho)	18						
Total sub-domains with nonaligned opinions (with -ve rho)	13						
Total congruent sub-domains above threshold rhos	12						
CIP_{SD}	$=(\rho^2)$ *100%=1.37%						

**Note:* D, UD, C, and NC denote Desirable, Undesirable, Congruent and Non-congruent, respectively.*

The low congruency index (CIP_{SD}=1.37%) reflects the feeble agreement of perception.

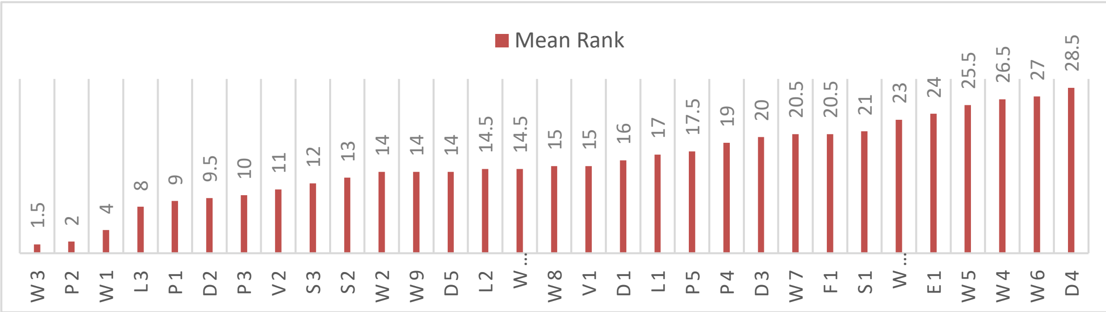


Fig. 3.2 Mean ranks value of sub-domains

3.3.1.2 Sub-domains desirability by Threshold Mean Rank (TMR) and Threshold Rho (TR) Values

The positive value of Spearman's rho (ρ_{SD} = 0.117) indicates a positive alignment of inter-group perception regarding the sub-domains but is lower than the acceptable rho limit (0.6). Only eight sub-domains have alignment above the threshold level of MRI and Rho.

3.3.1.3 Watershed Project Desirability Index (WPDI)

The eight sub-domains in the HR-HM quadrant (Fig. 3.3) are the most effective for calculating the watershed index. Here, n=8 and Σ (Rho*MRI) = 0.246,

Therefore, the Watershed Project Desirability Index (WPDI) = 8*0.246 = 1.966. The maximum WPDI value ($WPDI_{max}$) of an ideal watershed may be 729 (Because, in this framework, the maximum desirable sub-domains (n_{max}) =27, Rho_{max}=1 and MRI_{max}=1.)

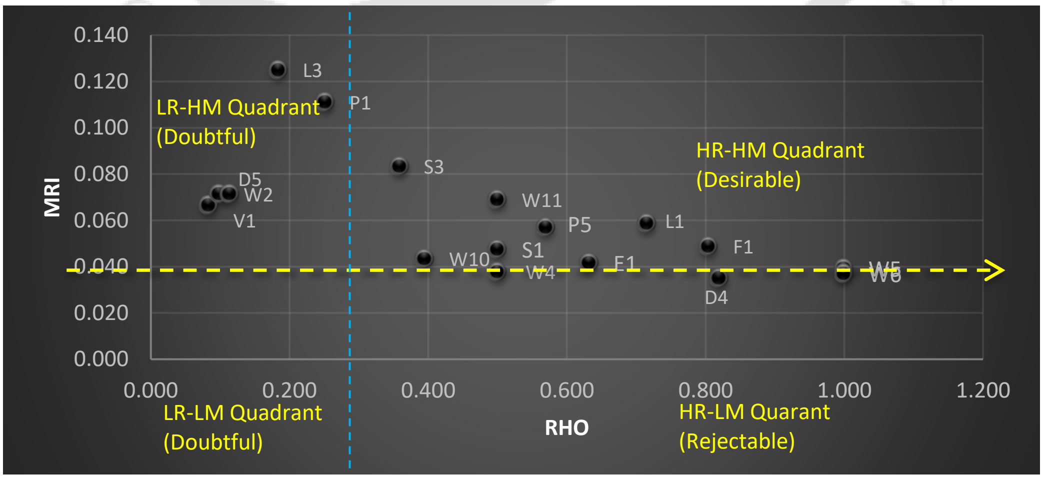


Fig. 3.3 Rho Vs. MRI plot for Satpokholi IWMP

**The horizontal dotted line shows a threshold MRI value (0.041), and the vertical dotted line shows a threshold rho value (0.300)*

3.3.1.4 Domains' desirability
Desirable Domains by Mean Rank

The rank given to each domain by the two stakeholders' groups and the mean rank scored by each domain are shown in Table 3.7.

Table 3.7: Group-wise domain rank, mean rank, and rho

Domains	Domain Ranking Gr1	Domain Ranking Gr2	Inter-group Rank Difference	Mean Rank	Rho on Rank Equivalent	CIP_D
Domain1: Land use and Morphology	2	2	0	2	-0.024	0.06%
Domain7: Environmental Activities	1	5	-4	3		
Domain3: Production and Economic Activities	6	1	5	3.5		
Domain4: Forest and natural landscapes	5	4	1	4.5		
Domain8: Development and Management	3	6	-3	4.5		
Domain2: Water and uses	4	7	-3	5.5		
Domain6: Socio-cultural Actions	8	3	5	5.5		
Domain5: Energy	7	8	-1	7.5		

Domain1 (Land Use and Morphology) (MR value two and inter-group rank difference 0) is the most desirable. Most of the action of water in a basin is conspicuous on the surface morphology of the area. Land use is primarily dependent on water flow behaviour. Hence, the choice of Domain1 as the most desirable domain is also the most realistic. Moreover, the inter-group rank difference of value zero indicates complete congruence of perception regarding the desirability of this domain. On the other hand, domain5 (Energy) is the least desirable (MR value of 7.5) for both stakeholder groups. This score is also realistic since most watershed areas under this study do not have any alternative energy generation or allied hydropower activities. The inter-group rank difference is highest for domain3 (Production and Economic Activities) and domain6 (Socio-Cultural Actions), which indicates that the stakeholders' perceptions

regarding these domains are the most incongruent. The incongruency of opinions in the case of Domain7 (Environmental Activities) is also significant.

Going more profoundly through the results, essential interpretations can be drawn regarding the perception of the stakeholders' groups. For example, Domain3 has the first rank among Group 2 stakeholders (consisting of the field-level watershed managers and watershed participants from the community). Still, its rank from the Group 1 stakeholders (consisting of water resource planners, academicians, consultants, and water management officers in the public sector) is 6. Such diversity of opinions regarding a critical watershed domain calls for urgent action from the watershed planners. The case for Domain6 and Domain7 is similar. Domain7 ranks one from Group 1, but its rank from Group 2 is 5. This indicates that Group 2 (the community group) has a lesser appeal for environmental activities, unlike the preference given by Group 1. Domain6 has the last ranking (8) from the Group 1 stakeholders, whereas its rank from Group 2 is 3. It infers that watershed management programs prioritise actions towards local socio-cultural development to enhance community participation. Thus, the disparity reflected by the result can provide valuable input from field-level stakeholders to develop effective interventions.

Congruency of inter-group perception on Domains (CIP_D)

Spearman's rho is calculated over the mean rank of both groups to test the alignment of the stakeholders' group's perception of the domains. The obtained rho (-0.024) value is weak, negative, and below the acceptable level of 0.3 (chosen for this study). Thus, it indicates a very feeble alignment of perceptions of both groups regarding the domains. Similarly, the CIP_D (0.06%) reflects the weak agreement.

Finally, the results show that the indexing method presented in this study can be applied to identify the desirable watershed objectives from the stakeholders' perspectives. The sub-domain desirability and WPDI rest on two primary threshold conditions that policymakers or water managers can arbitrarily assign: the rho value and the mean rank's threshold value. The choice of using Spearman's Rho value serves two essential purposes. Firstly, rho values enable us to measure stakeholders' perceptions, and secondly, they act as weightage factors with mean rank values in determining the final desirability decision.

Here, threshold rho and mean rank are assumed as 0.3 and 24.23 (85% of the hypothetical watershed performance parameters list), respectively. Watershed managers of different projects can use one hypothetical master list for every watershed project operating in an analogous hydro-sociological region or modify it as required. Then, before the final WPDI calculation, the project managers can check the validity of the master list for each project by calculating the validity index (VI).

3.3.2 Results Obtained from Kaldia and Turkunijan IWMP

The same WPDI framework and methodology were applied in the other two IWMP projects (Kaldia IWMP and Turkunijan IWMP, Brahmaputra Valley, Assam, India), having analogous hydro-sociological settings. The critical indices obtained are shown in Fig. 3.4.

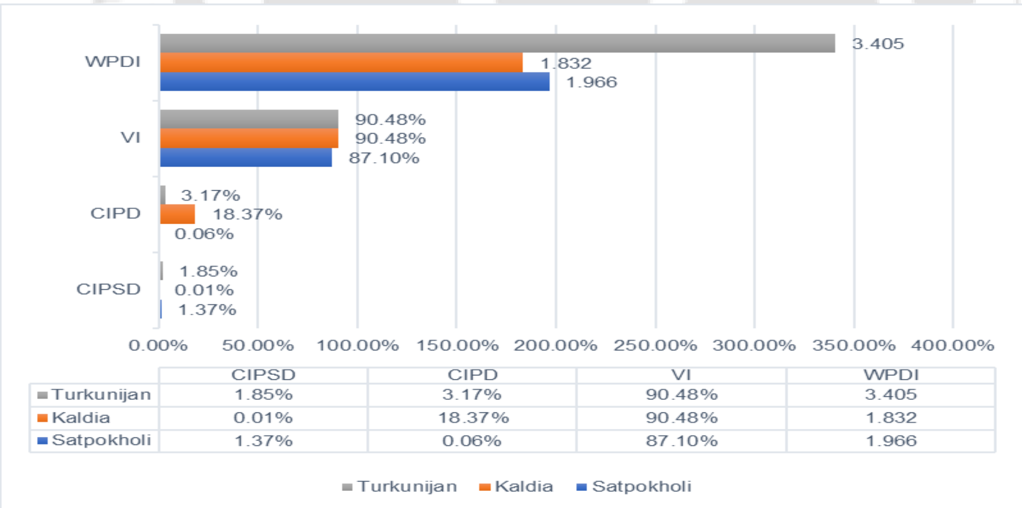


Fig. 3.4 Different indices of all three IWMPs

The results and indices values are cross-referenced with the local stakeholders of each project. There is broad consensus on the results. In all projects, the developed framework's validity indices (VIs) are above acceptable (The threshold is 60%). It corroborates one of the study objectives: an adaptable framework can be designed to measure watershed project desirability for watershed projects operating in a homologous regional setting.

From the results, three other valuable indices are derived, and they provide quantitative values about the complex qualitative attributes like stakeholders' perception of the planned project parameters, which are often very difficult to measure. Fulfilling the research aim, the indices will deliver vital insights into the effectiveness of the operating watershed projects to enhance community participation and design new interventions for project reengineering. A deeper introspection into the congruency of perception about sub-domains and parameters will enable watershed managers to assess and filter out the parameters with low congruency periodically.

Moreover, the WPDI framework is resilient enough to incorporate subjective threshold limits (for rho and MR values) in determining congruency as watershed managers decide. Policymakers and watershed managers can shorten the list of desirable parameters and make the obtained indices more stringent by increasing the threshold values with procedures mentioned in the methods section.

Comparing the functionality and effectiveness of different watershed projects operating in a region has been challenging for policymakers. In the present framework, many parameters are relatively universal; therefore, this evaluation methodology would apply to other IWMP projects with suitable modifications, if necessary. Thus, the project indexing method may greatly help the managers as a performance measuring and comparing tool. This study has evaluated three sets of different indices (WPDI, CIP_D and CIP_{SD}) for Kaldia, Satpokholi and Turkunijan IWMP, and policymakers can compare those values for introducing interventions. Here, the WPDI of Turkunijan IWMP has the highest value (3.405), indicating the best stakeholders' desirability amongst the studied projects. On the other hand, the lowest stakeholder desirability (1.382) is seen in the Kaldia project. In the case of Kaldia, higher congruency of perception on domains (CIP_D =18.37%) but very low congruency of perception on sub-domains (CIP_{SD}=0.01%) are observed. It indicates a higher disparity amongst the stakeholders' group in selecting the sub-domains. With deeper introspection, the concerned watershed manager might modify the parameters or initiate stakeholders' consultation to eliminate possible misconceptions. This way, watershed project planning could be made less abstract and more strategic for direct impact and clearly defined project goals, preferably with community involvement. This is crucial because local participation is proposed to achieve various goals, including sharpening poverty targeting, improving service delivery, expanding livelihood opportunities, and strengthening demand for good governance (Mansuri et al., 2004).

The methods proposed in this study would be helpful in alternative planning and decision-making in both project feasibility and operation stages. Applying ex-ante, the technique would help better collaborative planning, while using ex-post it would facilitate dynamic policy review for better sustainability, which had been a significant objective in watershed programmes (United Nations, 2015).

Another advantage of this indexing method is that, unlike many top-down evaluation strategies, it is based on a participatory approach, which would generate active participation of the general community and reduce future conflicts.

3.4 Summary

By design, watershed programmes are best carried out by stakeholders' participation. Policymakers and watershed managers strive for ways to potentially reduce incoherent stakeholders' perceptions and conflicting demands when they exist. Supplementing this objective, this study has proposed a methodology to explore the watershed parameters most desirable by the stakeholders' groups in IWMP projects. Pursuing a vital watershed management question, 'How can local people get involved in the complexities of planning, designing and managing the water resource issues?', this study examines stakeholders' desirability about the planned watershed parameters. It develops an indexing method for harmonising community participation.

An exhaustive parameters list covering watershed inventories that may be valid for a broad spectrum of watershed projects was constructed as the first step. The parameters, including the watershed project-level information and infrastructural inputs, are extracted from IWMP projects in Brahmaputra Valley, Assam (India). Then, suitable statistical methods are fitted to develop a hypothetical framework. Subsequently, the framework was applied in selected IWMP projects via a questionnaire survey to glean community information and stakeholders' perceptions of the theoretical watershed parameters.

The framework has the potential to filter the parameters by cross-examining two vital attributes: rank and stakeholders' aggregability. The findings show that in every project, some parameters have acceptable rank but unacceptable aggregability. Very few parameters have both acceptable rank and aggregability. Only these parameters are used to estimate the watershed project desirability index (WPDI), which has made the indexing method robust and unique. The WPDI of Satpokholi, Kaldia and Turkunijan IWMP projects are 1.966, 1.831 and 3.406, respectively. The framework substantially reveals critical misalignments of stakeholders' perceptions regarding the planned parameters of the studied watershed projects. The degree of misalignment could also be quantified to present a measurable state of affairs in watershed projects. The congruency of inter-group perceptions regarding the subdomains for Satpokholi, Kaldia and Turkunijan projects is 1.37%, 0.01% and 1.85%, respectively.

The findings also reveal that the framework will be a worthy tool to compare the effectiveness of different watershed projects regarding community participation in project planning. As the methodology is based on a participatory approach, it helps promote an environment that improves social learning and understanding of the water system, encouraging the exchange of knowledge and best management practices.

This study allows managers to compare the effectiveness of different watershed projects operating in analogous socio-hydrological environments. Regarding the generalisation of the framework, although many variables are relatively universal in this framework, making assumptions about which cases offer similar contexts is often challenging. The appropriate way to deal with the transferability of findings is to initiate a large number of case studies in the future to obtain statistically significant analyses. Besides contributing to watershed management, the developed methodology might be valuable in exploring specific aspects of the problem diagnosis and goal articulations in socio-economic endeavours where stakeholders' perceptions are diverse.

Every watershed manager should adequately organise the CBOs to sustain the community's willingness to continue. The next chapter presents the methodology for developing an indexing framework to measure the effectiveness of the community participation mechanism undertaken by a watershed manager and validation of the framework in selected IWMP projects.

Chapter 4 Developing a socially resilient multi-dimensional framework for bottom-up evaluation of community participation mechanism in a watershed project

4.1 Introduction

The previous chapter describes developing an index for evaluating community desirability regarding the adopted parameters in watershed projects. After selecting the most desirable parameters in the planning phase, the next important question before a watershed manager is: How to organise the community for the whole programme and measure how effective his community participation mechanism (CPM) is. This chapter contains the development of an evaluation framework for measuring the effectiveness of community participation actions in the organising phase of the watershed project.

Many South-Asian countries are implementing Integrated Water Resource Management (IWRM) and through Integrated Watershed Development Programmes (IWMP), employing community-based organisations (CBO) (Institute of Rural Management, Anand, Department of Land Resources Ministry of Rural Development, Government of India and The World Bank 2014; Mondal et al., 2020). For building societal resilience and protecting economic growth, engaging communities is seen to be both a desirable end linked to values of democratic participation and being of value because of correlations between participation and improved levels of social capital. Again, correlations between engaged communities and economic growth have been igniting further interest in the dynamic of community engagement (Adams D. & Hess M. 2005).

In the past few decades, many new approaches have evolved, paving the way for new types of organisations, institutions, and support systems (Hamidov et al., 2015) to achieve sustainable water management within the participating communities. Subsequently, the predominant challenges are shifting from the technical domain to community management that demands socio-hydrological watershed modelling (Blair & Buytaert, 2016; Jeong & Adamowski, 2016; Melsen et al., 2018; Seidl & Barthel, 2017).

Many experts and watershed policy documents suggest guidelines for better community participation to project-level watershed managers (Kerr, 2007; Heathcote, 2009; FAO, 2017). For the successful implementation of these guidelines and to devise an adaptive community participation mechanism in operational projects, examining the stakeholders' perceptions regarding the planned community objectives is essential. As success has always been the final goal of every activity, evaluating the success of a community participation mechanism is indispensable for watershed sustainability.

Once Lord Kelvin (Saxon, 2007) remarked, "When you cannot measure it when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." Likewise, a watershed project manager cannot improve community participation if it cannot be measured. Therefore, a framework for evaluating the adopted community participation mechanism (CPM) would be handy in watershed management. Policy-makers need readily available and easily manageable ways to deal with the new global scenario and bottom-up perspective (Crescenzi & Rodríguez-Pose, 2011). The FAO observed that an integrated conceptual toolkit that cross-fertilises bottom-up and top-down developmental policy practices is necessary rather than merely linking up indicators (FAO, 2019).

Contextually, this paper hypothesises an integrated socially resilient community participation evaluation framework (CPEF) that can be used to examine stakeholders' agreement on participatory actions. Here, the research questions are: i) What would be the dimensionality of the CPEF, and ii) How would the watershed actions be identified as the framework variables that would be the most appropriate from the stakeholders' perspective?

Understanding the watershed inventory involving community interest is the first step in assessing the conditions of a watershed ecosystem and the impacts of management actions on it. After that, the problem to be solved by the watershed managers should be clearly defined. Subsequently, the disparity between ideal and existing actions is evaluated for effectiveness.

In this line, extensive research and case studies were conducted to investigate the methods and variables related to community participation evaluation in watershed projects. There is a shortage of research on the bottom-up assessment of community participation in watershed management. In addition, most studies did not examine stakeholders' agreeability to planned project-level actions undertaken by the watershed managers in their community participation mechanism (CPM). The gap between the community participation mechanism (CPM) outcomes and the planned objectives has not been carefully explored and compared. Identifying the community participation actions and examining the agreement of different stakeholder groups on the state of affairs is essential for enhancing participation.

Subsequently, this study applies a survey in three watershed projects in the Brahmaputra Valley, Assam (India), to explore the critical organisational actions adopted by the watershed managers and to examine perceptions of the theoretical experts and field-level stakeholders on those actions to develop a community participation evaluation framework (CPEF). The dimensionalities (constructs), domains, and variables for the hypothetical CPEF are identified as encompassing the sets of significant organisational functionalities and operational management actions that are useable for the entire watershed project life cycle. Since a watershed project operates through a network of organisations with prescribed management actions, the project managers' organisational actions (OA) and critical management actions (CMA) would constitute the domains and variables of the CPEF.

Given the priority on watershed projects by many countries (Koontz, 2014; Mitchell et al., 2014; Murgue et al., 2015; Jeong & Adamowski, 2016; FAO, 2017; Yavuz, 2018; NITI Aayog, 2019), the findings of this study are valuable to facilitate efficient strategic intervention to redirect and the community participation mechanism adopted in a watershed project.

The methodology for developing the CPEF and the community participation index (CPI) is described in the following section.

4.2 Methods

4.2.1 Research Framework

The research framework can be summarised as given below:

1. Understanding watershed inventories: components and processes, water use, users, their needs, and problems.
2. Determining constructs and domains of the framework
3. Identifying management actions for each domain. They are the variables of the framework.
4. Selecting appropriate statistical analysis based on a questionnaire survey and semi-structured interviews to collect the alignment of stakeholders' opinions and examine the perceptions about the variables.
5. Eliminating the variables with significant differences of opinions to obtain the most agreed-upon CPEF.

This study investigated the operational policies and protocols of three IWMP project areas in the Brahmaputra valley in Assam (India) to develop the framework. The projects are: 1. Kaldia IWMP part III 2010-11 (SLNA, 2010a), 2. Turkunijan IWMP 2010 (SLNA, 2010c), 3. Satpokholi IWMP 2011-12 (SLNA, 2011a). These watershed projects were selected because they are within the same agro-climatic zone and have similar operating procedures. A comprehensive policy analysis was initially conducted to identify the definitions of watershed projects and their characteristics, benefits, and risks. Various watershed management actions proposed by researchers and those reported by practitioners and policy-makers to improve community participation were also identified, as discussed in the previous section.

The dimensionalities (constructs), domains and variables for a hypothetical CPEF, encompassing the project managers' organisational actions (OA) and critical management actions (CMA) to be used as variables of the CPEF, is structured as shown in Fig. 4.1.

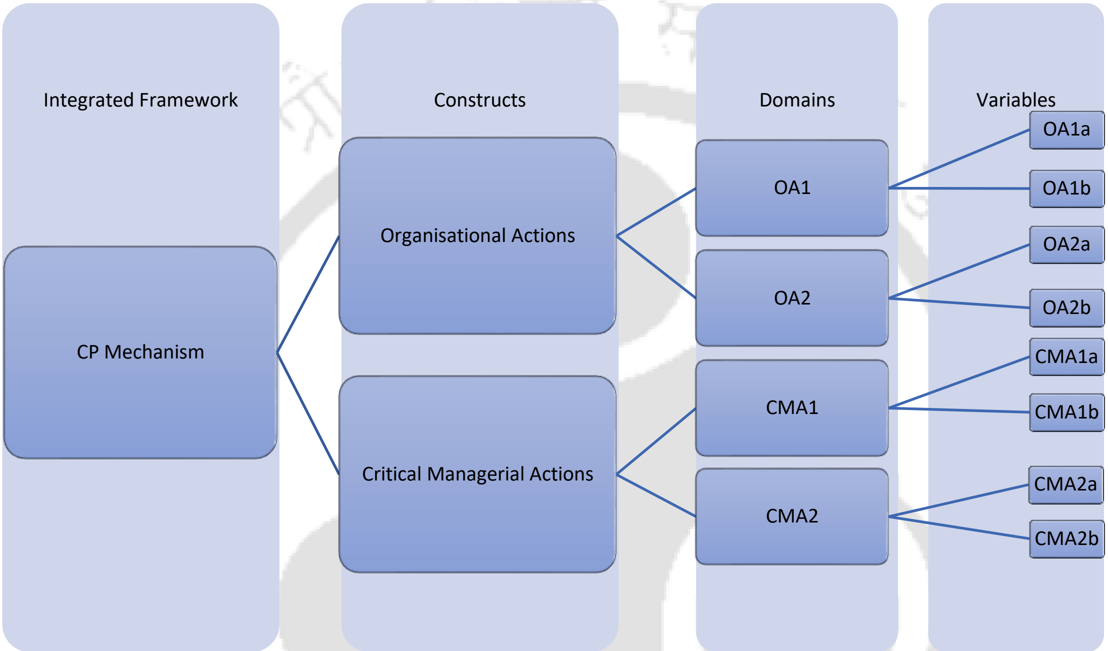


Fig. 4.1 The plan of the CPEF

Note: The integrated framework of CP evaluation shows the constructs, domains and variables. (Coding: Domains of constructs and variables are coded as OA1, OA2, …; CMA1, CMA2, …; OA1a, OA1b, …; CMA1a, CMA1b and so on.

4.2.2 Identification of CPEF Variables: Critical community management actions in the selected IWMP projects

The watershed projects selected for this study are designed based on the policies and IWMP protocols suggested by the government of India. The projects under IWMP have primary objectives for achieving sustainable community participation in watershed management (SLNA, 2010c). The Indian planning authority, NITI Aayog, has formed the State Level Nodal Agency (State Level Nodal Agency Assam, 2019) to manage and monitor IWMP-Assam projects. In their organisational structure, CBOs are the core component. The SLNA has a governing council under the Additional Chief Secretary's chairmanship to the Govt of Assam in the Department of Soil Conservation. For each IWMP-Assam project, a Programme Implementing Agency (PIA) is responsible for checking technical feasibility, budgeting and estimating, and implementation. The PIA forms the project participant groups in the project area to collaborate with local government organisations like Zila Parishads, Gaon Panchayatas, and CBOs. The structures and roles of the organisations actively involved in the operational level of a watershed project are defined by policy documents (Table 2.1). The watershed project management actions are planned to achieve robust community involvement (SLNA 2010b; Government of India 2011; Smyle, 2014; Gaur & Milne, 2015; NITI Aayog, 2019).

As summarised below, various critical management actions (CMA) and domains encompassing strategic actions can be sourced in the IWMP project documents and guidelines.

The critical factors grouping methods used by Ng S. et al. (Ng et al., 2012) are modified to include three additional domains affecting community participation in watershed management operations: organisational, developmental, and environmental. The final domain/categories of CMAs are shown in Table 4.1.

Table 4.1: Different domains of CMAs

a) Technical domain	b) Financial domain
c) Socio-cultural domain	d) Legal-institutional domain
e) Organisational domain	f) Environmental domain
g) Developmental domain	h) Economic domain

The variables (parameters) related to these domains can be found in the literature and project documents. (These are presented in Table 4.3).

4.2.3 Data Collection and Data Analysis Framework

A structured questionnaire (Appendix Table A4.1: CPEF Survey questionnaire sample) is designed based on the list of hypothetical variables to examine stakeholders' general qualitative attitudes towards watershed management actions. The questionnaire was directly distributed to the individuals as it was framed for a participatory approach, where many respondents from the community needed an introduction (Appendix A4.2: CPEF survey respondents' details). To record the usually unquantifiable level of stakeholders' perception, questions are fitted with a 2-point scale so that the answers reflect the respondents' unambiguity. Respondents choose 2 when they agree and 1 when they disagree. Non-parametric statistical techniques are used to analyse and filter the variables to measure the difference in opinion. The summary of the applied statistical methods is shown in Table 4.2.

Table 4.2: Statistical methods applied.

Test for	Applied Statistical Tests
Interrater Reliability	Krippendorff's Alpha (Kalpha)
In-group Consistency	Cronbach's Alpha (α)
Correlation	Pearson's Coefficient (r)
Validity by measuring the Degree of Alignment of inter-group perceptions	Spearman's Rho (ρ) or Rank correlation coefficient
Validity by measuring Acceptance Level	Percentage Agreement
The similarity of Agreement Score Mean	T-tests on average of both group
Filtering of identified Variables	Coefficient of Variation (CoV)

Using a random sampling approach, survey participants were classified into two groups: i) Watershed Policy Experts and ii) Field level Managers and community. The first group includes three sub-groups: the academicians, public sector water experts and field-level watershed experts, and the second group includes two sub-groups: the field-level watershed managers and community stakeholders. The justification for choosing these two groups is that, in enhancing community participation, there appears to be a large gap between the perception of theoretical experts and field-level stakeholders. The respondents were selected based on having more than ten years of experience in the watershed field. A total of 30 valid responses were received out of about 100 questionnaires administered, representing a response rate of 30%.

The final CPEF is used as a basis of a structured questionnaire (Appendix A 4.8) with four rating preferences (0=Not done, 1=Somewhat done, 2=Partially done, 3=Done) to collect community opinion on the participation actions undertaken by watershed managers. These data are used to obtain three watershed projects' community participation indices (CPI).

4.3 Result and Discussion

4.3.1 The hypothetical CPEF

Analysing the policies and guidelines, the activities planned for developing the community can be grouped into two categories (DoLR, 2015). The first is related to the design of participant organisations, and the second is related to the defined management actions. Based on this, there can be two broad constructs for the CPEF: i) Organisational Construct and ii) Critical Management Construct. Subsequently, the organisational construct accommodates the desirable organisational procedures or actions involved in the organisational management related to the organisation's formation, development and idealised behaviour. These actions (from now on denoted as 'Organisational Actions' or OA) are gathered from policy documents (SLNA 2010a; Bagdi et al., 2015; Gaur & Milne, 2015; NITI Aayog, 2017) are grouped into five domains, one each for every project-level organisation, as shown in Table 4.3.

Table 4.3: The constructs, domains and variables of the hypothetical CPEF

Constructs	Domains under the constructs	Variables/ actions
ORGANISATIONAL ACTIONS (OA)	OA1- Villages/ Local governments like Gram Sabha operation	Q1-OA1-a: Numbers of villages covered
		Q2-OA1-b: Villagers' activeness and willingness to continue
	OA2- Water Users' Group Operation	Q3-OA2-a: Proper mode of user group selection.
		Q4-OA2-b: Merit-based selection.
		Q5-OA2-c: Provision of organisational training.
		Q6-OA2-d: Users' activeness and willingness to continue.
	OA3- Watershed Developmental Committee Operation	Q7-OA3-a: Proper mode of WDC selection
		Q8-OA3-b: Merit-based selection.
		Q9-OA3-c: Provision of organisational training.
		Q10-OA3-d: Willingness to continue.

	OA4- Watershed Development Team Operation	Q11-OA4-a: Adequate formation of the watershed technical team
		Q12-OA4-b: Attentiveness of the watershed technical team to local problems.
		Q13-OA4-c: Promptness of the watershed technical team to service.
		Q14-OA4-d: Participation of the watershed technical team in planning and budgeting.
		Q15-OA4-e: Coordination of the watershed technical team in auditing.
		Q16-OA4-f: Coordination of the watershed technical team in project actions.
	OA5- Self Help Group Operation	Q17-OA5-a: Active association by SHGs.
		Q18-OA5-b: Periodic training about their roles.
		Q19-OA5-c: Willingness for inter-group cooperation.
		Q20-OA5-d: Willingness for helping problem mitigation.
CRITICAL MANAGEMENT ACTIONS (CMA)	CMA1- Organisational Domain Management	Q21-CMA1-a: Well-defined mode of transfer/ role allocation/authority sharing from providers and participants.
		Q22-CMA1-b: Contract flexibility between providers and participants.
	CMA2- Technical Domain Management	Q23-CMA2-a: The project is technically manageable by the users.
		Q24-CMA2-b: Provision of differential service and supply facility for the users.
		Q25-CMA2-c: Provision for Definite and measurable service quality.
		Q26-CMA2-d: Power availability.
		Q27-CMA2-e: Scheduling and timeliness.
		Q28-CMA2-f: Scope of innovation and adaptability.
	CMA3- Legal/Institutional Domain Management	Q29-CMA3-a: Legality and flexibility of pricing
		Q30-CMA3-b: Compatibility of rules and norms with the statute and standard law practices.
		Q31-CMA3-c: Scope of dispute management.
		Q32-CMA3-d: Provision of distinct authority sharing.
		Q33-CMA3-e: Secured land tenure policy.
		Q34-CMA3-f: Government support in rules and legality.
		Q35-CMA3-g: Resilience to political sensitivity.
	CMA4- Financial Domain Management	Q36-CMA4-a: Awareness of the community about financing mode/investment opportunities
		Q37-CMA4-b: Awareness of the community about the profitability of the project.
		Q38-CMA4-c: Community adopting the accounting/auditing practices
		Q39-CMA4-d: Awareness of the community about the project B/C ratio
		Q40-CMA4-e: Faith of the community about the stability of financial policies

		Q41-CMA4-f: The financial appeal of the project to the community.
		Q42-CMA4-g: Scope for private funding in the project
	CMA5- Economic Domain Management	Q43-CMA5-a: Existence of feasibility study before project planning.
		Q44-CMA5-b: Existence of demand forecasting in project planning.
		Q45-CMA5-c: Effectiveness of the project for meeting long-term demand.
		Q46-CMA5-d: Scope of extension service delivery.
		Q47-CMA5-e: Scope of common-pool resource management.
		Q48-CMA5-f: Scope for financial auditing.
		Q49-CMA5-g: Project inducing stability to the economic environment.
	CMA6- Socio-Cultural Domain Management	Q50-CMA6-a: Value addition to the socio-cultural cohesion.
		Q51-CMA6-b: Equitable service delivery
		Q52-CMA6-c: Inducing job opportunities.
		Q53-CMA6-d: Effective rehabilitation/ compensation policies
		Q54-CMA6-e: Scoping for social return on investment.
		Q55-CMA6-f: Acceptable tariffs/ levies.
		Q56-CMA6-g: Encouraging constructive migration of people
	CMA7- Environmental Domain Management	Q57-CMA7-a: Initiating environmental sustainability.
		Q58-CMA7-b: Inducing soil degradation prevention
		Q59-CMA7-c: Emphasise for pollution prevention.
	CMA8- Developmental Domain Management	Q60-CMA8-a: Arranging developmental training and workshops for stakeholders.
		Q61-CMA8-b: Demonstrating evidence of enhanced capability/ resource utilisation.
		Q62-CMA8-c: Encouraging Case study/ analysis/ qualitative feedback amongst stakeholders.
		Q63-CMA8-d: Effort for controlling staff/stakeholders' performance/ engagements.
		Q64-CMA8-e: Scoping knowledge/ best practices management.
		Q65-CMA8-f: Introducing rating policy.

Note: The integrated framework of CP evaluation shows the constructs, domains and variables. (Coding: Domains of constructs are coded as OA1, OA2…CMA1, CMA2….and so on. Here, alphabets denote the construct, and the numbers denote domains. Variables are coded in three parts: Q1-OA1-a, Q2-OA1-b…Q65-CMA8-f …and so on. The first part denotes the variable serial number in the entire list, the second part denotes the construct followed by the domain number, and the third part denotes the variable number in its domain)

4.3.1.1 Domains and Variables of Organizational Construct

The five domains encompass the IWMP-OAs related to five project-level participant organisations (Table 4.3). The IWMP project area must include all the villages of the basin. Moreover, villagers should be enthusiastic and willing to continue in IWMP activities. So, 'the numbers of villages covered' and 'villagers' enthusiasm and willingness to continue' are necessary actions in the domain 'OA1-GS operation'.

The Watershed Users Group is a significant community group. For the domain 'OA2-WUG Operations', various actions like employing a proper selection mode, a merit-based selection process, and providing developmental training and users' willingness to continue are considered critical. Similar variables are also relevant for the Watershed Development Council in the OA3-WDC Operation domain. The WDT is the primary organisation for scheduled watershed activities, such as planning, budgeting, implementing, and auditing project activities. It should be attentive and prompt in problem-solving. Besides, adequate formation procedures and provision of training for the members are essential for an effective WDT. Accordingly, OAs for the domain 'OA4-WDT Operations' are included. Regarding the domain 'OA5-SHG Operations', the degree of participation can be assessed by looking into how actively the members associate and how willing they are to enhance inter-group cooperation in problem mitigation. As only periodic training can motivate the CBOs about their roles, the training/workshops' numbers indicate CP effectiveness.

4.3.1.2 Domains and Variables of the Critical Management Actions Construct

In the critical management actions construct, the CMAs are grouped into eight domains (Table 4.3).

The CMA1-Organisational domain variables are relevant for fixing the property rights of the created assets in IWMP to ensure risk transfer to the stakeholders for sustainability. Therefore, the mode of asset transfers, role allocation, authority sharing, and contract flexibility between providers and participants should be well-defined. Accordingly, the pertinent variables are incorporated.

Variables in the CMA2-Technical domain include CMAs related to the technical capability of the project. IWMP projects should not be very technically complicated and must be manageable by the community. Whenever the service quality is well-defined and measurable, only scheduled, differential, and timely service can be provided. Therefore, a few essential technical requirements are ensuring service reliability, power availability and provisioning for innovation and adaptability.

The willingness of the watershed participants positively correlates with the actuality of legality and flexibility of service/ supply/pricing, compatibility of rules with statutes and institutional development, the scope of dispute management, distinct authority sharing, secured land tenure policy, government support to rules, and resilience to political sensitivity. The related CMAs are selected as variables for the CMA3-Legal/Institutional domain.

The CMA4-Financial domain includes the financial manoeuvrability of the project. The participants' understanding of financing mode/investment opportunities and evoking acceptable tariffs/ levies is essential for recognising its profitability. Besides, the participants should know how to compute the B/C ratio and implement accounting and auditing policies. The community's belief in the stability of government financial policies determines the financial appeal of the project. The participants coming out to invest is an indicator of the attractiveness of a project. Therefore, the project's private funding scope is crucial for engaging the participants.

The CMA5-Economic domain includes various economic activities for the local communities. The economic impact of meeting long-term demand reflects the success of an IWMP project. Again, the positive impact is possible only when the planners initiate an appropriate feasibility study and demand forecasting before project planning. A project is supposed to bring stability to the economic environment, necessitating the provisioning of extension service delivery and common-pool resource management. Managers should also adopt financial auditing in the project area. From this standpoint, pertinent economic variables are selected in the Economic Domain.

A community will participate better when the project adds value to socio-cultural cohesion and equitability. The project should have the potential for job creation, inducing constructive mobility on people's migration and promoting social return on investment. Sometimes, projects dislocate inhabitants from their places, necessitating acceptable rehabilitation/ compensation policies. Therefore, variables in the CMA6-Socio-cultural domain substantially affect generating CP.

Variables in the CMA7-Environmental domain cover generating community support in environmental sustainability, inducing soil degradation prevention and pioneering pollution prevention.

Variables in the CMA8-Developmental domain encompass enhancing social learning. Provision for developmental training and workshops to encourage case analysis and qualitative feedback is essential for watershed managers. Demonstrating evidence of enhanced capability/ resource utilisation, providing best practices management and instituting rating policy inspire stakeholders. Since the watershed activities revolve around local conditions, initiating periodic appraisals of staff and stakeholders' performance is essential.

Thus, 20 IWMP-OAs (variables) in the organisational construct and 45 IWMP-CMAs (variables) are identified in the management construct in the hypothetical CPEF (Table 4.3).

4.3.1.3 Variables analysis

Various statistical tests were adopted to examine the rationality of the CPEF variables and filter out the variables having unacceptable values. Table 4.4 shows the applied tests, obtained values, inferences and standard limits (Appendix A4.3: CPEF correlation result).

Table 4.4: The applied tests and obtained values

Test for	Groups	Values of Statistical Coefficients/P-values	Observations/ Inferences	Commonly accepted value limits
Interrater Reliability	Gr1	Kalpha=0.5690	15% below the acceptable limit. Low reliability	1≥Kalpha≥0.8 is acceptable

	Gr2	Kalpha=0.9268	Acceptable Reliability	
In-group Consistency	Gr1	α = 0.94	High	1≥α ≥0.7 is acceptable
	Gr2	α = 1.00	Excellent	
Inter-group Correlation	Both	r = 0.7882 Obtained p-value = 0	The correlation is positive and strong	1≥r>0.5 is strong
Validity by measuring the Degree of Alignment of inter-group views/perception	Both	A) ρ = 0.8810 Obtained p-value = 0 B) ρ^2= 0.7762	A) The degree of agreement is positive and strong. B) 77.62% of respondents have agreed on variable acceptance C) It is higher than the critical rho value (Here, ρ –crit=0.245) from Spearman's table at a 95% confidence level.	1≥ρ >0 indicates a positive association
Validity by measuring Agreement Level	Gr1	84.62%	Strong agreement level	Limiting Values can be chosen arbitrarily
	Gr2	80%	Strong agreement level	
	Both	80%	Strong agreement level	
The similarity of Agreement Score Mean	Both	Obtained 2-tailed t-test p-value 0.0796 (at 95% confidence level, t-stat=1.7701, t-crit=1.9833, df=102.7528)	The mean of the aggregate score is statistically similar	If p-value < 0.05, reject the H_0 (Here, H_0=The mean of both groups is similar)
Filtering of Accepted Variables	Gr1	Obtained CoV values are either zero or other than zero.	Rejected Variables have non-zero CoV.	Arbitrarily chosen that a variable is rejectable if CoV value≥0 (i.e., variables with lowest CoVs are more robust)
	Gr2	Obtained CoV values are either zero or other than zero.	Rejected Variables have non-zero CoV.	

Kalpha shows inter-rater reliability between the two selected groups of raters. Its advantages are: a) It ignores missing data, b) it Can handle various sample sizes, categories and numbers of raters, and c) it Applies to any measurement levels (i.e., nominal., ordinal, interval and ratio). For Gr1, Kalpha (0.5690) is about 15% below the desirable limit. The low value reflects the disparity of agreement between the persons in the Gr1, including the academicians and water resource department officers in the public sector. Conceivably, a difference of perception between academic experts and field experts may occur, as the academicians might miss some ground-level information. For Gr2, Kalpha (0.9268) shows a good agreement amongst the raters. The internal consistency or scale reliability measure shows how closely related a set of items/variables are as a group. The Cronbach's Alpha for Gr1 (0.94) and Gr2 (1.00) shows excellent consistency of opinions. The Alpha values indicate that the CPEF variables are homogeneous (Appendix A4.4: Kripendorff Alpha analysis for CPEF) (Appendix A4.5: Inter-group agreement and CPEF Chronbach Alpha analysis).

In measuring the correlation between the inter-group scores, the alpha coefficient value, 0.7882, indicates a strong correlation between the opinions of Gr1 and Gr2.

The Spearman's Rho (ρ) is a non-parametric measure of rank correlation after each group's scores are ranked in order. It conveys how well the relationship between the two groups can be described using a monotonic function. It is observed that: A) the ρ value (0.8810) is very close to +1. This agreement level is positive and strong, B) 77.62% of respondents have agreed on variables acceptance, C) ρ is greater than the critical rho value (Here, ρ –crit=0.245) from Spearman's table at 95% confidence level.

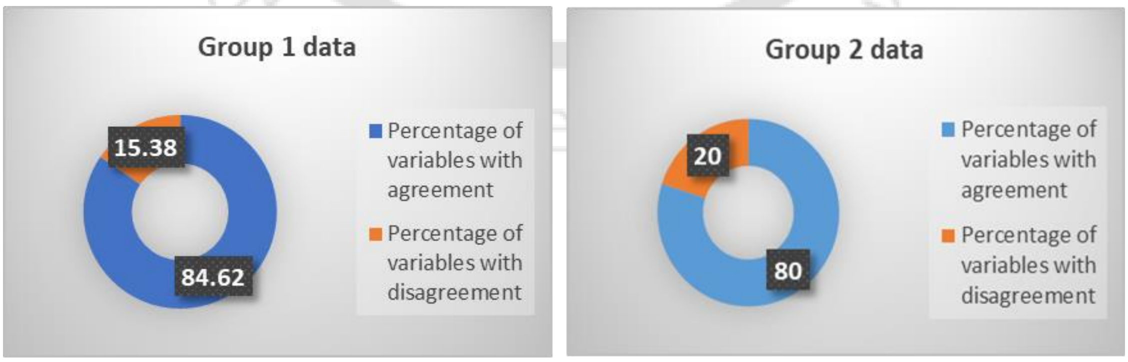


Fig. 4.2 Agreement on variables by Group 1 and Group 2 respondents

The percentage agreement scores are shown in Fig. 4.2. The high agreement score concludes that the variables list is acceptable and valid for the CPEF. Practically, the agreement score of the selected groups should be statistically similar. Two-sample t-tests of the average agreement score of both groups ascertain this. The p-value of 0.0796 (at 95% confidence level, 2-tailed) indicates that the mean score is statistically similar.

In the CPEF, the variables with the most robust agreement scores are desirable. The CoV of each variable is calculated separately for each group to filter out the least robust variables. The variables with CoV values greater than zero are rejected. The rejected variables are shown in Table 4.5. (Appendix A4.6: T test for CPEF)

Table 4.5: List of rejected variables

List of rejected variables and acceptance level of the CPEF by CoV Score					
Rejected Variables	Variable code in hypothetical CPEF list	CoV Gr1	CoV Gr2	Ranking by Gr1	Ranking by Gr2
Merit-based selection of WUG	Q4-OA2-b	0.3590	0	56	55
The proper mode of selection for WDC	Q7-OA3-a	0	0.1664	1	48
Merit-based selection of WDC	Q8-OA3-b	0.3379	0	52	52
The proper mode of WDT formation	Q11-OA4-a	0.1579	0	48	50
Participation of WDT in planning and budgeting	Q14-OA4-d	0	0.2852	1	46
Contract flexibility between providers and participants	Q22-CMA1-b	0.3590	0	39	40
Provision of definite and measurable service quality	Q25-CMA2-c	0.36998	0	39	38
Managers' concern about power availability	Q26-CMA2-d	0.2224	0	36	38
Scope for private funding in the project	Q42-CMA4-g	0	0.3629	24	20
Existence of demand forecasting in project planning	Q44-CMA5-b	0	0.3581	1	19
Scope of common-pool resource management	Q47-CMA5-e	0.3670	0.2179	19	17
Scoping for social return on investment	Q54-CMA6-e	0.3590	0	11	11
Introduction of rating policy	Q65-CMA8-f	0.3590	0	1	1

Total Number of rejected variables out of a total of 65 variables	13	9	5		
Acceptance Level (Percentage of Accepted variables out of a total of 65 variables)	80	86.15	92.31		

(Note: Variables are coded in three parts, as Q1-OA1-a, Q2-OA1-b…Q65-CMA8-f and so on. The first part denotes the variable serial number in the entire list, the second part denotes the construct followed by domain number, and the third part denotes the variable number in its domain.)

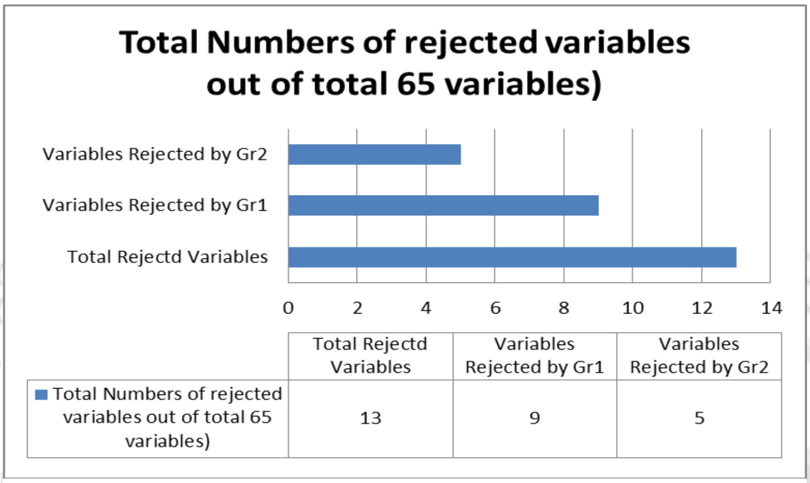


Fig. 4.3 Number of rejected variables

The CoV score shows that out of the total 65 variables in the hypothetical CPEF, the number of variables rejected by both groups is 13. Group-1 has rejected nine, and Group-2 has rejected five variables (Fig. 4.3). The stakeholders agree upon 80% of the total 65 variables, which is the overall acceptance level of the hypothetical CPEF.

Summarising all the results, the 52 most agreed-upon actions have been finalised for the CPEF (Appendix Table A4.7: List of 52 Final CPEF variables/indicators).

4.3.2 Validation of the CPEF in IWMP projects

The CPEF is validated in three selected projects according to the methods described in section 4.2.3. (Appendix 4.8: CPI data analysis Turkunijan IWMP - Sample page).

4.3.2.1 Kaldia IWMP

In Kaldia IWMP, the community disclosed that the watershed managers do not undertake many essential CP actions (68.61%), and only 0.23% were wholly taken up. Other 30% of targeted CP actions were poorly initiated (Fig. 4.4).

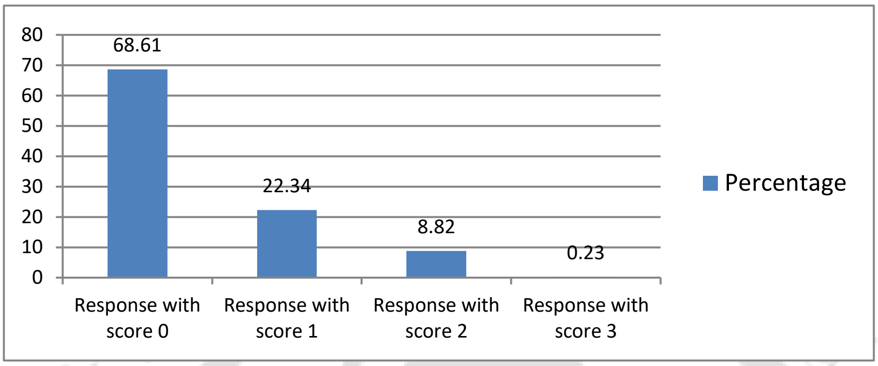


Fig. 4.4 Percentage of respondents in different score categories in Kaldia IWMP

In Kaldia IWMP, the CPI is low (13.29%). Here, the CP domain scores ranged from 7.41% to 18.06%. The most attended domain is CMA8 (18.06% CP actions attended), and the least attended is CMA4 (7.41% CP actions attended) (Fig. 4.5).

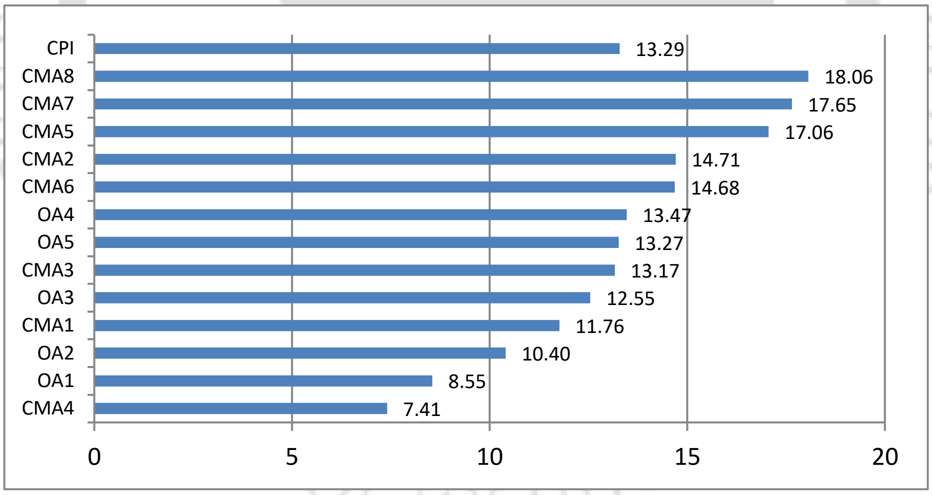


Fig. 4.5 Sub domain wise percentage score in Kaldia IWMP

4.3.2.2 Satpokholi IWMP

In Satpokholi IWMP, the community disclosed that the watershed managers did not undertake many essential CP actions (81.25%), and only 3.81% of the essential CP actions were wholly taken up. Other 15% of targeted CP actions were poorly initiated (Fig. 4.6).

In Satpokholi IWMP, the CPI is low (9.53%). Here, the CP domain scores ranged from 5.75% to 19.11%. The most attended domain is OA1 (19.11% CP actions attended), and the least attended is CMA1 (5.75% CP actions attended) (Fig. 4.7).

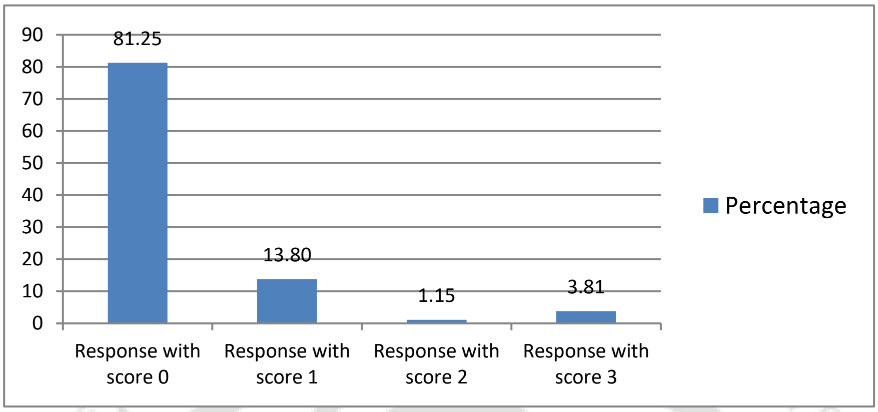


Fig. 4.6 Percentage of respondents in different score categories in Satpokholi IWMP

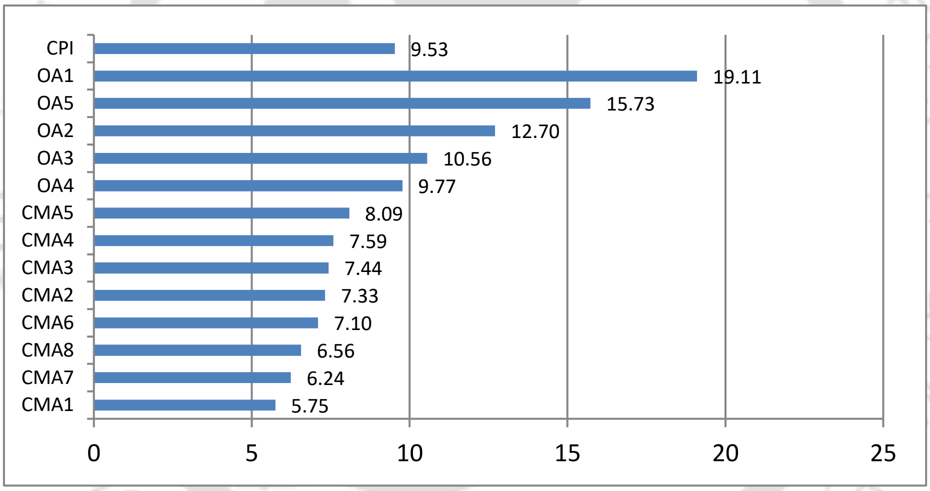


Fig. 4.7 Subdomain percentage score in Satpokholi IWMP

4.3.2.3 Turkunijan IWMP

In Turkunijan IWMP, the community disclosed that the watershed managers did not undertake 28.64% of essential CP actions, and only 12.83% were entirely taken up. Other 58% of targeted CP actions were lackadaisically initiated (Fig. 4.8).

In Turkunijan IWMP, the CPI is appreciable (43.54%). Here, the CP domain scores ranged from 33.17% to 52.59%. The most attended domain is CMA4 (52.59% CP actions attended), and the least attended is CMA3 (33.17% CP actions attended) (Fig. 4.9).

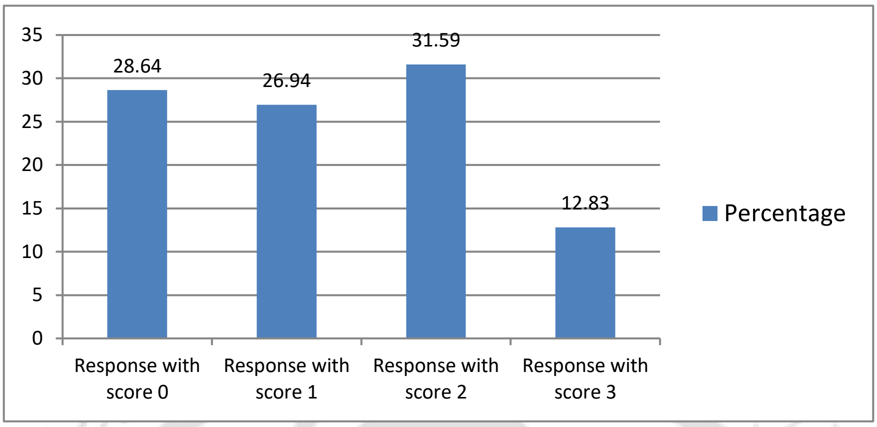


Fig. 4.8 Percentage of respondents in different score categories in Turkunijan IWMP

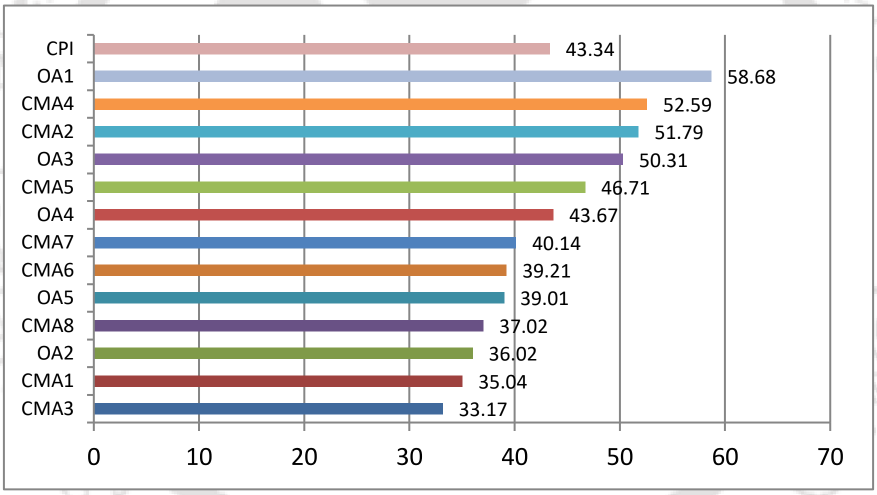


Fig. 4.9 Sub domain wise percentage score: Turkunijan IWMP

4.3.2.4 Overview of all projects

The results of all three projects are discussed below (Fig. 4.10).

The number of entirely unattended CP actions is very high in Kaldia and Satpokholi IWMP, except in Turkunijan IWMP. The response percentage given to the different score levels revealed that Turkunijan IWMP had undertaken better community participation efforts per the planned objectives. The same result is reflected by the CPI values (Table 4.6).

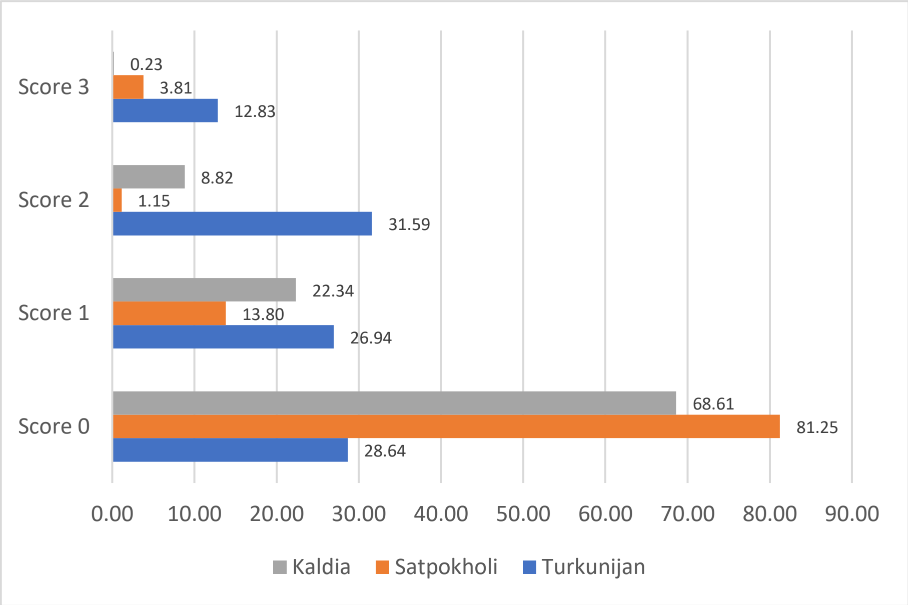


Fig. 4.10 Response Percentage at Different Score Levels

Table 4.6: CPI of All IWMPs

IWMPs	**CPI**
Kaldia	13.29%
Turkunijan	43.34%
Satpokholi	9.53%

The stakeholders' agreement regarding the CPEF is 80% (Fig. 4.6). When this framework is applied to the Kaldia, Satpokholi and Turkunijan IWMP, the measured community participation indices are 13.29%, 9.53% and 43.34%, respectively (Table 4.6). It indicates that the community participation mechanism in Turkunijan was the most effective compared to the other two IWMP projects. The survey has four score levels (Score 0, 1, 2 and 3) that the respondents can choose. The response percentages at different score levels are shown in Fig. 4.8. This response percentage on different scores can reveal some vital indications of community participation insufficiencies. In Satpokholi IWMP, with the lowest CPI score, 81.25 % of the respondents marked zero scores, and only 3.81 % chose the highest score, 3, for the questions. This shows a high degree of dissatisfaction with the project CPM. In comparison, Turkunijan IWMP has the highest CPI (43.34%) and the highest response percentage (12.83%) for scores 3. 0, 1 and 2, which show an almost equal percentage response. Similarly, in Kaldia IWMP, where CPI has the second highest value (13.29%), a large percentage of respondents (68.61%) have chosen zero score and a very meagre 0.23% of respondents have chosen a score of 3.

4.4 Summary

This framework's uniqueness is that, departing from subscale development for CP evaluation like many previous researchers, it offers an integrated CPEF, and unlike the most common top-up assessing procedures, it is adoptable through a participatory approach.

Commonly, watershed managers follow top-down monitoring procedures, and usually, there is no formulation of any participatory evaluation framework for CP assessment. A top-down monitoring exercise fails to reflect the social rationality of a watershed project. Consequently, it does not facilitate a dynamic review of acts and rules to enhance social learning or incorporate project goals and guidelines. For example, the NITI Aayog, India, identifies essential watershed indicators and benchmarks for incorporating the project objectives with a project-specific baseline for target achievement (State Level Nodal Agency Assam, 2008). They emphasised reporting achievements like "Total number of assets created under IWMP," "Total irrigated command area," and so on. One significant objective of the Aayog is social audit and process monitoring in watershed projects. However, with a top-down appraisal policy, many ambitious procedures become mere bureaucratic measures that usually show dubious appraisals skewed from reality. Eventually, such policies pushed forward by watershed professionals disengage the community (Ludwig et al., 2014; Giordano & Shah, 2014). Therefore, it is vital to accommodate appraisal indicators from a participatory or bottom-up perspective. This framework might be helpful as a metric for continuous and comprehensive evaluation of CP efforts in participatory mode when fitted with a valid questionnaire for IWMP project participants. The IWMP projects of the Indian sub-continent have broadly analogous socio-cultural settings and community expectations. Therefore, this model evaluation framework would improve community engagement for system redirecting, goal articulation and sustainability in similar watershed spaces.

This research's value will be to inform governments and participants on reorganising resource planning and service delivery at a policy level. The CPEF, as a tool, has excellent potential for inseminating good social behaviours, which are obtainable through observation and imitation of best management practices in the IWMP project areas. With proper implementation of a participatory tool like this, new behaviour and motivation may evolve merely through practising and following up, even without direct coercion. The focus on best practices management embedded in the developed CPEF will initiate later research on social learning in watershed management. While working with this model, any future researcher, policymaker, or water manager may include more case studies on various watershed projects to verify further the applicability and reliability of the variables identified in this study.

After organising, the next important watershed management aspect is project implementation. Every project must perform according to the planned objectives, and stakeholders' perceptions of performance must be positively aligned. The next chapter describes a methodology for framework development to index stakeholders' perceptions regarding project performance and the result of validating the framework in selected watershed projects.

Chapter 5 Developing a participatory framework for evaluating watershed performance

5.1 Introduction

Watershed performance assessment from the perspective of the beneficiaries is exceedingly difficult due to the vagueness of performance variables and the region-specificity of the project goals. This chapter elaborates on constructing a performance indexing framework for watershed projects and its validation in selected project areas with the following steps:

- Mapping the planned objectives and project targets in selected watershed projects to identify the critical performance evaluation variables.
- Designing a participatory performance evaluation framework (PEF) for indexing project performance based on the degree of target achievement.
- Validating the PEF to obtain watershed projects' performance indexes (PI).

In assessing a watershed project, the first thing that arises is: what is the success of a watershed project? The project is successful if it is effective in fulfilling the goals.

Discussing watershed effectiveness, Kenney observed that watershed initiatives are successful if they contribute to achieving on-the-ground objectives defined by prevailing social norms. Discussing 36 watershed studies, he also said that 60% of respondents listed 'participation by stakeholders' and about 25% of respondents listed 'problems with on-the-ground project goals' as key to success (Kenney, 2000). With that perspective, the effectiveness at the community level can best be evaluated by examining whether the needs and expectations of those groups within a community have a direct and indirect interest in seeing that their needs are adequately met. Therefore, it is crucial to explore and quantitatively evaluate the community's expectations, prioritisation, and alignment regarding project goals and realised achievements to design an adaptable framework for bridging the gap between watershed performance and planned importance.

Researchers have outlined key success performance indicators (Hooper B., 2010; African Network of River Basin Organisations 2010; Mohamed et al., 2015). Mostly, these indicators are generic and prescribed with universal connotations (Hooper B., 2010; Hooper B.P., 2006a). In this context, more studies need to be done on the performance assessment of each watershed project in a localised context. In addition, existing watershed evaluation protocols mainly focus on acquiring data from estimated assets or expenditures made for a top-down appraisal where the perspective of the beneficiaries is not taken care of. Commonly, watershed project baseline study, benchmarking, and monitoring and evaluation are entrusted to centralised agencies. The monitoring procedures mainly assessed the structural components of an IWMP project using a top-down method. The monitoring system has also been upgraded using the Geographical Information System (GIS) and Management Information System (MIS) to investigate watershed performance. They seem to have focussed more on technical assessment than socio-economic impact assessment (Department of Land Resources, Government of India, 2015; Mondal et al., 2020; Nagaraja B, 2015). Contextually, it is necessary to assess the IWMP performance from the perspective of the beneficiaries. There is an absence of a comprehensive framework for a performance assessment that can be used in participatory mode. Therefore, one objective of this study is to construct a performance indexing framework for watershed projects and to validate existing project areas.

Here are some pertinent questions: How can the relevant watershed performance variables be identified, and how can the disparity between performance and planned importance be gauged?

To answer these questions, this study aims to design a participatory performance evaluation framework (PEF) for indexing watershed project performance supported by field-level community information. The research objectives are a) Mapping the planned importances or targets of selected watershed projects to use them as the variables of the PEF, b) Introducing a methodology to quantify community perceptions about the project achievements, and c) Validation of the PEF in selected projects in Brahmaputra Valley, Assam to obtain their performance index (PI).

A field survey is carried out in three IWMP projects in the Brahmaputra Valley, Assam, to explore the critical variables (goals) for evaluating watershed performance and examining the community perception of those variables to obtain a performance measuring index. The framework, being applicable in a participatory manner, has the potential to enhance community participation and efficiency in project implementation. Since the watershed programs in Assam are congruent with the IWMP protocols initiated by the Government of India (NITI Aayog, 2019; SLNA, 2010c), the developed methodology is valuable for watershed projects with analogous socio-economic environments elsewhere in Assam and India.

5.2 Methods

The research methodology adopted includes i) a literature review and content analysis of watershed project documents to classify the most common watershed developmental goals as PEF variables, ii) semi-structured focused group interviews of experts for coding goal categories, iii) inter-coder reliability testing to identify project goals categories, iv) validating PEF with a questionnaire survey in the study areas and statistical analysis.

5.2.1 Content Analysis for PEF Variables

Understanding that the project is successful if it effectively fulfils the goals, a comprehensive literature review was conducted to list sustainable watershed projects' most common characteristics and goals. Guidelines of DoLER (State Level Nodal Agency Assam, 2008;

Indicators and Benchmarks for Watershed Management Outcomes Institute of Rural Management Anand, Department of Land Resources Ministry of Rural Development, Government of India and The World Bank, 2014), NITI Aayog (NITI Aayog, 2017), SLNA objectives (State Level Nodal Agency Assam, 2019), and detailed project documents of different projects in Assam (SLNA, 2010c, 2010a) are reviewed. After cross-checking the validity of the obtained goals list, a thorough qualitative analysis was done to determine the activities planned in the selected watershed projects. The primary project goal categories and the most common IWMP developmental goals are extracted from project reports and field studies (State Level Nodal Agency Assam, 2008, 2011a; Indicators and Benchmarks for Watershed Management Outcomes Institute of Rural Management Anand Department of Land Resources Ministry of Rural Development, Government of India and The World Bank, 2014; State Level Nodal Agency Assam, 2019; SLNA, 2010c, 2010a, 2010b, 2011a).

Table 5.1: The primary IWMP goal categories with common goals

Goal Category Code	Goals Categories	Goals Descriptions
A	Naturalisation and Afforestation	Altering land's vegetative cover by afforestation and forest protection to counteract land and ecosystem degradation and naturalisation efforts such as removing dams and weirs to improve aquatic habitats
B	Socio-Economic Upgradation	Improve livelihoods, human development, economic outcomes, and nutritional health and reduce distress migration. Integrating socio-economic considerations to benefit communities within the watershed
C	Soil and Land Development	Controlling soil erosion and runoff velocity by building check dams, spillways, farm ponds, embankments, and water distribution canals
D	Water Resource Management	Installing hand pumps, tube wells for drinking water, rainwater conservation, groundwater recharge, and rejuvenation of water bodies
E	Agricultural Production and Best Management Practices	Providing irrigation facilities, high-yielding variety seeds, multiple cropping, and establishing markets. Best management practices for better productivity
F	Animal Husbandry and Pisciculture	Integrating livestock management with farming activities and sustainable grazing practices. Pisciculture and apiculture to restore ecosystem health

G	Social Capital Development	Including diverse community members and representation from reserved communities and women is crucial for successful engagement, proper coordination between agencies and consideration of different perspectives among water users
H	Associated Infrastructure Development	Community development includes developing and renovating public utilities such as roads, bridges, parks, playgrounds, markets, and school compounds

Subsequently, a list of performance variables comprising 75 relevant variables in 8 categories is prepared. Then, focus group discussions were held with three IWMP project stakeholders to finalise the list. The FGD members arrived at a list of 65 variables in 8 categories of goals to be included in the PEF. (Table 5.2: Final 65 variables).

Table 5.2: Final performance evaluation goal categories with goals

A Naturalisation and Afforestation

1. Increasing vegetative cover of the project area.
2. Protecting Forest area.
3. Restoration of degraded ecosystem.
4. Afforestation.

B Socio-Economic Upgradation

1. Facilitating micro-enterprises like handloom, pottery making, carpentry, mobile repairing, vermin compost, bamboo craft, and tarja making.
2. Creating person-days to reduce labourer migration.
3. Improving human development.
4. Enhancing combined economic outcome.
5 Controlling distress migration.
6. Training the Users' Groups.
7. Ensuring SHGs are formed to include people under the poverty line.
8. Ensuring the formation of UGs, including female members.
9. Ensuring the formation of UGs, including SC/ST members.
10. Ensuring the formation of UGs, including BPL members.
11. Training of the SHGs to be active and alert.
12. Training the UGs to be active and alert.
13. Formation of targeted numbers of Users' Groups.

C Soil and Land Management

1. Controlling soil erosion/siltation
2. Building check dams, drop spillways, farm ponds, and earthen embankments.
3. Construction of water distribution canals.
4. Construction of earthen dams to arrest the runoff water.
5. Protecting the paddy fields from inundation by the flood.
6. Decreasing velocity of runoff water.
7. Plantation on the roadside, river bank, and institutional campus.

D Water Resource Management

1. Installation of hand pumps and tube wells for drinking water.
2. Encouraging rainwater conservation/soil moisture retention.

3. Encouraging groundwater recharges through surface water storage, dug-out ponds, ring wells
4. Providing alternatives for rejuvenation of water bodies/water budgeting.
5. Install shallow tube wells, ponds and hand pumps to meet drinking water needs.

E Agricultural Production

1. Providing water pumps for Kharif crops.
2. Encouraging multiple cropping.
3. Raising irrigation potential for different crops in a drought situation.
4. Increasing cropping area.
5. Encouraging area under horticulture.
6. Encouraging quality and high-yielding varieties to raise rice production.
7. Raising the production of rice through the creation of small irrigation facilities.
8. Encouraging processing of different agricultural products like cereals, oil seeds, fruits, etc.
9. Facilitating agricultural marketing of surplus produce like cereals, oil seeds, fruits/ milk etc.
10. Arranging crop demonstration programmes on different agricultural produce.
11. Achieving targeted growth of the cropped area.
12. Achieving targeted growth of cash crops like jute.
13. Achieving targeted growth of the wheat crop.
14. Achieving targeted growth of crops like pulses and oil seeds.

F Animal Husbandry and Pisciculture

1. Improving pisciculture
2. Facilitate fish rearing and construction of firm ponds and fishery ponds.
3. Increasing milk production.
4. Providing training on weaving/ fishery/ dairy/ goatery and poultry.
5. Developing rearing of livestock and poultry for asset-less/marginal labourers.
6. Helping assetless/marginal labourers SHGs with schemes of rearing cows, poultry, piggery, duckery, beekeeping, etc.

G Social Capital Development

1. Improving gender equality.
2. Improving social cohesion.
3. Helping to improve the nutritional needs of users.
4. Training the Self-Help Groups.
5. Training the Watershed Committees, which Gram Sabha forms.
6. Undertaking participatory rural appraisal exercises like participatory modelling and evaluation.
7. Coordinating between project implementing agency (PIA) and beneficiaries.
8. Forming the Producers' Collective group and motivating them to the project activities.
9. Facilitating collaboration of watershed managers with the village community.
10. Facilitating collaboration of watershed managers with gram panchayatas (GP)/ DRDA/ ZP cells.
11. Motivating the watershed committee (WC) to be active and alert.
12 Motivating the SHGs formed by the watershed committee.
13 Conflict resolution between the watershed organisation and villagers.

H Associated Infrastructure Development

1. Developing children's parks and historic sites
2. Building roads and bridges
3. Providing public utility

Five watershed experts are invited to code the listed goals to validate the goal categories. Krippendorff's inter-coder reliability test (Kalpha reliability) was executed on their observations (Krippendorff, 2011). (Appendix A5.1: Sample Inter-rater Reliability (Kalpha) testing list regarding categories of goals in a watershed project)

5.2.2 Survey Areas

Three IWMP projects were selected based on three primary considerations: i) covering three different regions with analogous project protocols and goals prescribed by SLNA (SLNA, 2010c, 2010a, 2011a), ii) covering both banks of the Brahmaputra River with similarity of socio-economic scenarios, and iii) cooperative attitude and response of the local community. (Table 5.3)

Table 5.3: Watershed projects selected for the study

Watershed Projects	*Developmental Block*	*District*	*Region*
1. Kaldia IWMP part III (2010-11), Code 3A2A7/4	Bajali	Barpeta, Assam	North bank of Brahmaputra River
2. Turkunijan IWMP (2010-11), Code 3A2A6/a2	Bajali	Barpeta, Assam	North bank of Brahmaputra River
3. Satpokholi IWMP (2011-12), Code 3B1C8	Rampur and Choyaniborduwar	Kamrup, Assam	South Bank of Brahmaputra River

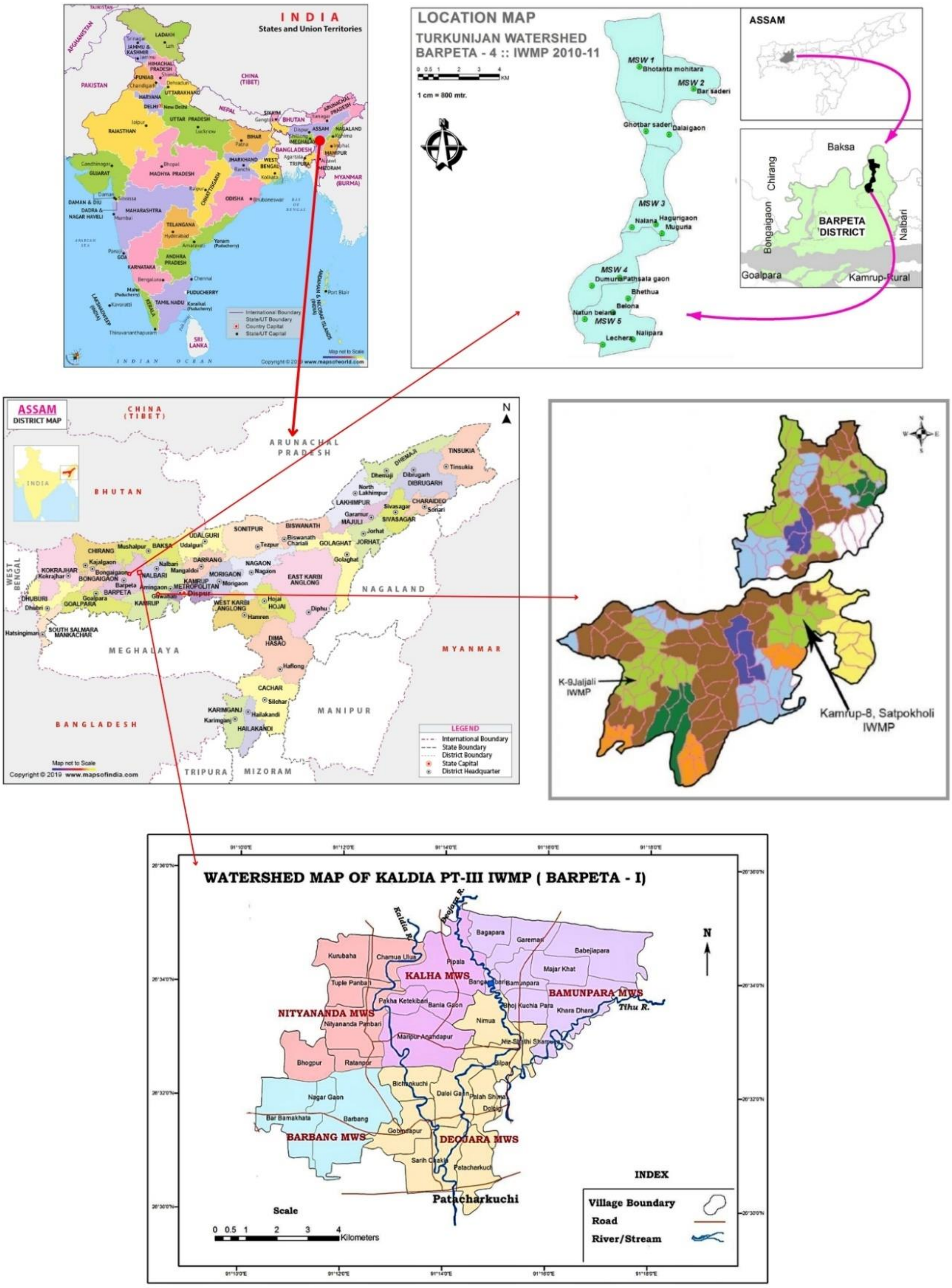


Fig. 5.1 Maps of Assam and IWMP project areas under this study

(Source: Detailed Project Report of Satpokholi, Turkunijan and Kaldia IWMP)

5.2.3 Survey Methods

Pilot interviews were conducted with five watershed experts to examine the local practice of assessing the performance of IWMP projects and to validate the compiled list of PEF variables. They consented to the identified variables. Subsequently, a structured close-ended questionnaire protocol with a 4-point ratio scale ('0 for not started or disagree', '1 for started or somewhat agree', '2 for partially completed or agree', and '3 for completed or strongly agree') is done amongst the randomly selected project beneficiaries (Table 5.4: Respondents' general characteristics). A ratio scale is quantitative with true zero and equal intervals between neighbouring points (Bhandari, 2023).

Table 5.4: Respondents' general characteristics

		Kaldia IWMP	Satpokholi IWMP	Turkunijan IWMP
Number of questionnaires sent out		150	200	170
Number of completed questionnaires received		50	72	58
Response Rate		34%	36%	34%
General Characteristics of Respondents				
Gender	Male	35	50	38
	Female	15	22	20
Type of Stakeholder	Watershed Managers	5	5	5
	Community	30	55	38
	CBOs	10	7	10
	Local govt	5	5	5
Occupation	Teacher	6	6	6
	Student	6	6	6
	Govt. Service	5	8	10
	Farmers	18	37	21
	Businessman	5	5	5
	Homemakers	10	10	10

5.2.4 Data Analysis

5.2.4.1 Goal-wise, Category-wise Performance Score (CPS) and PI Calculation

The score of each goal is calculated below.

Let, in any goal category 'A' having n numbers of goals, the score of the i-th goal is denoted by GAi, where i= 1, 2, 3…. n. For each goal, respondents gave a mark between 0 and

3. Now, if the number of respondents giving 0, 1, 2, and 3 scores are R_0, R_1, R_2, and R_3, respectively, then Gai = (Total Marks given to that goal)/(Maximum mark for that goal) = $(3*R_3+ 2*R_2+1*R_1+0*R_0)/ (R_3+R_2+R_1+R_0) *3$, the Category-wise Performance Score of category A (CPS_A) would be the summation of marks given to all the goals in that category, i.e. $CPS_A = \sum Gai$.

The different measurements of the evaluation criteria should be reduced to a standardised scale to be manipulated to treat them as standard measures. Heathcote suggested standardisation and imposing weights for effective evaluation criteria for fully utilising available community information and priorities, considering differences between alternatives to make a clear-cut final choice (Heathcote, 2009).

The scores are grouped to impose weights for PI calculation (Table 5.5).

Table 5.5: Score levels and weights imposed for PI calculation

Score level	Number of goals with this score level	Weight
Zero Score	N_o	0
Above 0 to 10%	N_1	1
Above 10% to 20%	N_2	2
Above 20% to 30%	N_3	3
Above 30% to 40%	N_4	4
Above 40% to 50%	N_5	5
Total performance score of a project (TPS)	$= \sum N_i*i$, where Ni=Numbers of goals for ith score level, i=0,1,2,..10	

Note: Upper Score levels are not shown as they are irrelevant. The highest possible weight is 10 for a score level of 90%-100%.

The maximum performance score (MPS) of a project = Total Number of goals in the project*Maximum weight. Since we have 65 goals in each project, MPS=65*10=650. The performance index is defined as (TPS/ MPS) % (the maximum PI of a watershed project can be 100%). For the projects under study, individual PI is calculated.

5.2.4.2 Breakup of Opinions and Percentage of Zero Score (PZS)

This study has used four score levels denoted by S_i (Here, i=0, 1, 2, and 3). The breakup of opinions is calculated as follows:

Percentage of ith scores (S_i) = 100*Number of responses with ith score / Total Response. Accordingly, the percentage of zero scores (PZS, denoted by S_0), the percentage of one score (S1), the percentage of two scores (S2), and the percentage of three scores (S_3) are obtained. For a good project, S_3 should be high, and S_0 should be low. The PZS seems valuable as the zero scores are marking and do not indicate abstention. The higher the PZS, the lower the performance. For detailed investigation, the PZS can be calculated goal-wise, category-wise, and project-wise.

5.2.4.3 Validation

Results derived from the survey were cross-referenced amongst community members and watershed managers for validation.

5.3 Results and Discussion

The Krippendorff's Alpha for inter-coder reliability testing is 0.78, which indicates the acceptability of the goal category list (Appendix A5.2: Kripendorff Alpha analysis)

5.3.1 Performance Scores and Index

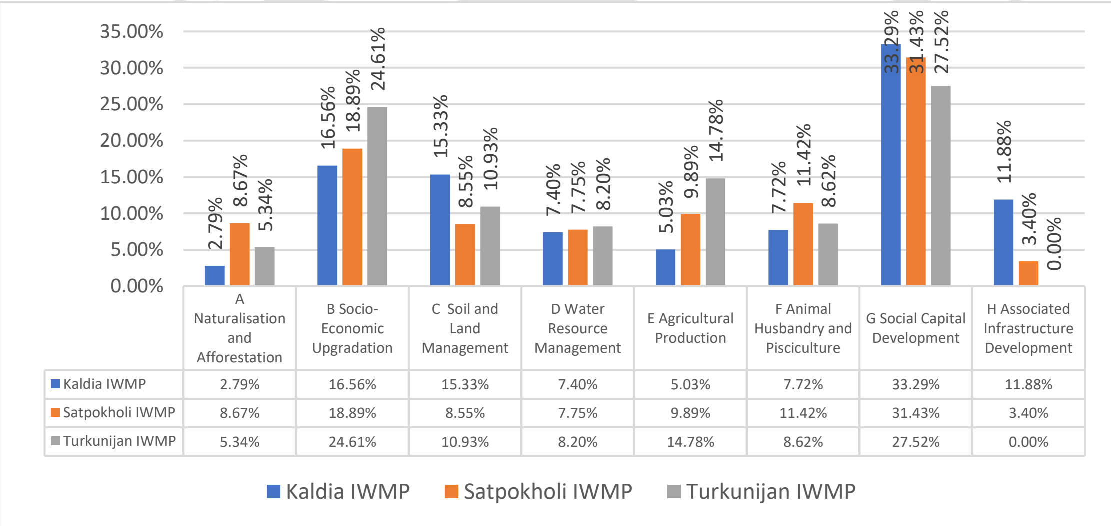


Fig. 5.2 Category-wise Performance Scores of All IWMPs

The goal-wise performance score of the three IWMP projects is calculated (Appendix Table A5.3 Goalwise Perf Score all IWMP). The goal-wise and category-wise performance scores (Fig. 5.2) reveal stakeholders' opinions on performance. It would tell watershed managers how each goal category is performing. Of all the projects, the goal category "Social-capital Development' has the highest performance (about 27 to 33%). This is obvious as users' demand for different goals in this category is high. The category "Socio-economic upgradation" has the second highest performance in all the projects (about 16 to 24%). The three low-performing categories are "Naturalisation and Afforestation," "Water Resources Management," and "Associated Infrastructure Development." One reason may be that the goals under these categories involve higher costs than the other categories.

Then, project-wise performance and PI are calculated (Table 5.6).

Table 5.6: Project-wise Performance Indices

		Kaldia IWMP		Satpokholi IWMP		Turkunijan IWMP	
Score levels	Weights	Number of goals	Weighted Score	Number of goals	Weighted Score	Number of goals	Weighted Score
Zero Score	0	6	0	0	0	3	0
0 to 10%	1	30	30	61	61	1	1
10% to 20%	2	4	8	4	8	18	36
20% to 30%	3	22	66	0	0	22	66
30% to 40%	4	1	4	0	0	16	64
40% to 50%	5	2	10	0	0	5	25
TPS			118		69		192
PI		18.15%		10.62%		29.54%	

From the definition, the maximum PI of a watershed project can be 100%. However, the IWMP projects studied have very low PIs. The Turkunijan IWMP has scored the maximum PI value of 29.54%. Out of 65 planned targets, a maximum of 22 targets have only a 20% to 30% score. The Kaldia IWMP has a PI value of 18.15% and a maximum of 30 targets with a 0% to

10% score. Here, 62 targets out of a total of 65 targets obtained scores below 30%. The PI of Satpokholi IWMP is very low (10.62%), and all 65 targets scored below 20%.

Thus, the developed performance assessment framework has given us a clear picture of the functioning of the watershed projects studied. Table 5.7 shows a few performance parameters.

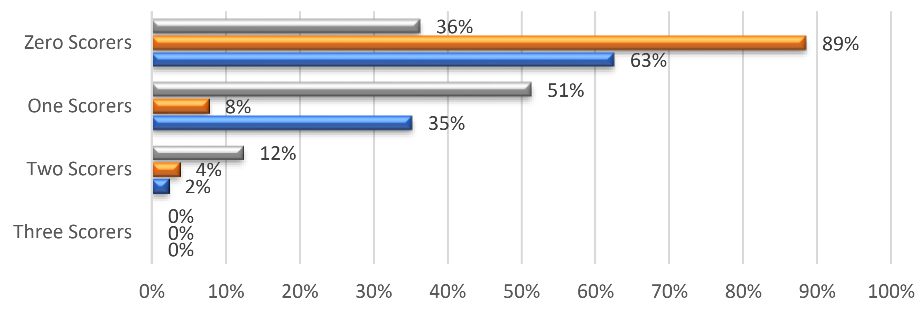
Table 5.7: A few significant goal categories in the studied projects

	Kaldia IWMP	Satpokholi IWMP	Turkunijan IWMP
Highest Performing Category	Social Capital Development	Social Capital Development	Social Capital Development
Least Performing Category	Naturalisation and Afforestation	Associated Infrastructure Development	Associated Infrastructure Development
Performance Index	18.15	10.62	29.54

Policymakers might use the category-wise performance score to compare, remodel, and manage best practices. 'Social Capital Development' is the highest-performing category. This is reasonable because this category includes building community organisations, the primary objective of IWMP. In Satpokholi and Turkunijan IWMP, 'Associated Infrastructure Development' is the minor scoring category. This category is also anticipated because it is not a primary IWMP objective.

5.3.2 Percentage of Responses at Different Score Levels

The breakup of opinions against different score levels (Fig. 5.3) is shown below. No person has given a maximum mark (3) to any goal in all three projects. This shows that project performances are far from the maximum. In Kaldia and Satpokholi, the maximum number of people gave zero scores to the goals (S_0 values are the highest, 63% and 89%, respectively), which shows their dissatisfaction with performances. In Turkunijan, S_1 and S_2 are the highest, and S_0 is the lowest compared to the other two projects. It reflects better performance in Turkunijan compared to Satpokholi and Kaldia.



	Three Scorers	Two Scorers	One Scorers	Zero Scorers
Turkunijan	0%	12%	51%	36%
Satpokholi	0%	4%	8%	89%
Kaldia	0%	2%	35%	63%

Fig. 5.3 Breakup of Opinions with Different Scores Level-All IWMPs

Similarly, the category-wise PZS (S_0) values (Fig. 5.4) show stakeholders' opinions on non-performance in different goal categories.

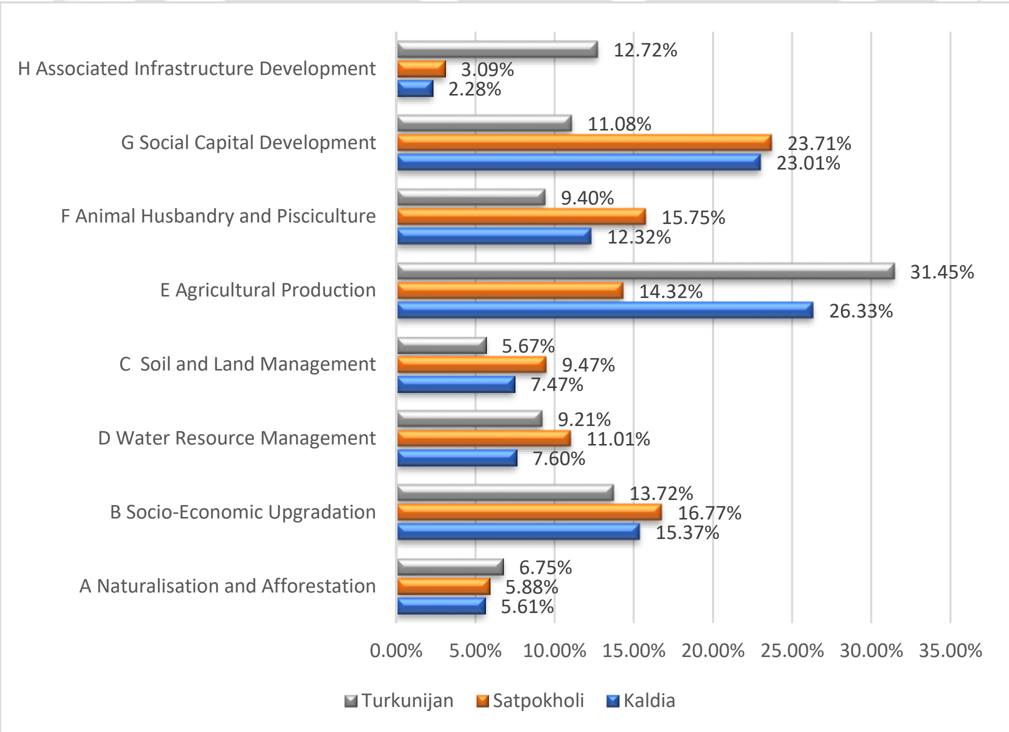


Fig. 5.4 Category-wise Percentage of Zero Score for All IWMPs

From the PZS values on goal categories, it is seen that the category "A" (Naturalisation and Afforestation) has performed better (PZS being below 7% in all projects). The performance of categories "C" (Soil and Land Management) and "H" (Associated Infrastructure and Development) is also of the same level, except in Turkunijan IWMP, where the public expectation might be higher than the achieved. The categories "G" (Social capital Development) and "E" (Agricultural Production) have shown higher non-performance (with the PZS values ranging from 11 to 31%). Looking at this result, project managers may go for a detailed analysis of the performance score of the pertaining goals (already obtained by the applied methodology) to detect the bottlenecks (as described in section 3.1).

Project-wise, Kaldia has two lowest performing categories, "G" and "E" (PZS 26.33% and 23.01% respectively). Here, category "H" and category "A" show better performance by PZS (2.28% and 5.61% respectively). In Satpokholi, category "G" is the worst performer, with the highest PZS of 23.71%. Here, category "H" is the highest performer (PZS=3.09%). In Turkunijan, the worst performer is the category "E" (PZS=31.45%). Here, the two top-performing categories are "C" (PZS=5.67%) and "A" (PZS=6.75%).

Some high and low-performing categories by PZS analysis are shown below (Table 5.8)

Table 5.8: Some high and low-performing categories by PZS analysis

Performance	Kaldia IWMP	Satpokholi IWMP	Turkunijan IWMP
High Performing Category	H and A	H	C and A
Low Performing Category	G and E	G	E

This concurs with the fact that Turkunijan is a recently completed project, and work on Satpokholi is delayed due to field-related reasons. Here, all 65 goals scored below 20%. In the Kaldia IWMP (PI 18.15%), a maximum of 30 goals has a 0% to 10% score. Validators agreed that works in Kaldia are different from the plan. According to validators, the PEF would facilitate baseline study and benchmarking of IWMP projects as desired by NITI Aayog.

5.4 Summary

This study aimed to design a participatory performance evaluation framework (PEF) for bridging the gap between achievement and planning goals in a watershed project. Per the research objective, a framework (methodology) is developed and validated in IWMP projects with similar protocols to show how participatory performance indexing is feasible to obtain a quantified performance score. The framework variables are identified by analysing the goals of the three selected projects with analogous settings operating in Brahmaputra Valley, Assam. Using the framework, the performance indices (PI) of the Kaldia, Satpokholi, and Turkunijan IWMP projects are obtained to be 18.15%, 10.62%, and 29.54%, respectively. Thus, the developed performance assessment framework presents a quantitative expression of the performances of the watershed projects studied. Hence, the developed methodology fulfils two necessities of watershed managers: i) Expressing performance by a quantitative value and ii) incorporating community perceptions for assessing project outcomes. Usually, watershed programs are assessed by accounting for the number of assets created or fund flow to the project in a top-down procedure. However, from the point of watershed effectiveness, performance evaluation should focus on the parity of the project goals and the accomplishment against them. Moreover, since watershed initiatives are community-based collaborative programs, meaningful evaluation procedures should incorporate the community's perspective. Expressing performance quantitatively would help watershed policy-makers to dynamically calibrate and compare the effectiveness of different projects in the same regional settings.

Besides providing project-wise performance scores and indexing, the developed framework has the potential to provide community perceptions about various goal categories (expressed as the percentage of different score levels and zero scores).

Although the NITI Aayog (Aayog, 2019; NITI Aayog, 2017) has proposed watershed guidelines with broadly relevant indicators to facilitate participatory practices in watershed management, there still needs to be a formulation for ground-level evaluation incorporating community perspectives. Contextually, the framework developed in this study would be helpful for watershed project managers. The developed methodology is applicable to accommodate the perception of the watershed beneficiary group. A similar methodology can be used to capture the perceptions of other stakeholder groups. The variables are selected with a broader region view to incorporate the most common issues. Therefore, with slight modification, the framework and goal categories might be used for performance indexing of various projects in an analogous socio-economic setting with similar IWMP protocols. However, a separate survey for data collection would be necessary for individual projects.

In evaluating performance, this study has refrained from proposing any threshold or goal-post values. Therefore, the obtained results cannot be used for inter-project comparison. However, policymakers can arbitrarily choose threshold values for similar watershed projects to make the framework a performance-comparing tool. A series of in-depth case studies on various watershed projects should be launched to enrich the applicability and reliability of this PEF and enhance watershed effectiveness.

The next chapter describes an indexing method for measuring the involvement of the participant organisations and their function-sharing.

Chapter 6 An indexing method for evaluating the managerial effectiveness and functional involvement of participant organisations in watershed project

6.1 Introduction

The Integrated Watershed Management Programme (IWMP) envisages participatory watershed management by building and developing community-based organisations (CBOs). These CBOs are an integral part of all IWMP projects, and therefore, the overall success of these programs depends on how efficiently CBOs are linked into the watershed organisational structure (Fawcett et al., 1995; Kozlowski & Bell, 2012; Sreedevi et al., 2008; FAO, 2019). However, a conglomerate of organisations with inefficient function shares cannot induce management transfer of created assets, regardless of the lofty objectives.

So, the question is: Are the present participant organisations getting involved in the process as expected?

Therefore, the managerial effectiveness of organisations in performing essential management functions is vital. In this study, we propose two indexing methods: a) A Project Management Effectiveness Index (PMEI) to gauge the degree of overall managerial effectiveness of a watershed project by measuring what management functions are covered in the project, and b) An Organizational Involvement Index (OII), to gauge the degree of managerial involvement of various participant organisations, by measuring the number of management functions performed by all organisational elements. A project's Watershed Management Index (IWI) can be defined as the summation of OII and PMEI.

Firstly, we derived the functional management theory's universal management processes and functions for human endeavour. Then, we undertook a structured open-ended questionnaire survey amongst the randomly selected inhabitants of an IWMP project area in

Assam to determine the management functions of different participant organisations. The indexing system is built on an analysis of the quantified opinions of the respondents.

Different indices are obtained for the surveyed projects. Notably, the management function share is unevenly distributed, and most surprisingly, some participant organisations have zero managerial involvement.

This management function indexing system will help the watershed planners track and compare the management environment at different points of time or compare the functional status of various projects. In addition, it will facilitate the design of suitable interventions for the management process reengineering for more congruent function sharing. Another speciality of this indexing method is that it is a participatory tool based on community information.

6.1.1 Integrated Watershed Management Programme (IWMP) Organisational Structure

Many states in India have been implementing watershed projects under IWMP with significant objectives for achieving sustainable community participation (NITI Aayog, 2019). The Indian planning authority, NITI Aayog, has formed the State Level Nodal Agency (SLNA) for the overall planning, management, and monitoring of IWMP projects, emphasising the indispensability of CBOs in the organisational infrastructure (SLNA, 2010c). In addition, IWMP guidelines acknowledge collaboration among local government organisations like Zila Parishads, Gaon Panchayatas, Schools, and Voluntary Organisations (Gaur & Milne, 2015). Table 2.6 shows some details of the prescribed participant organisations.

6.1.2 What are the managers supposed to do?

The term ‘management' refers to getting things done effectively and efficiently through and with other people. Managers use the functional management theory approach to plan, organise, lead, and control (Robbins, 2013). In the early part of the twentieth century, French Industrialist Henry Fayol mentioned five categories of essential management processes or functions: Planning, Organising, Commanding, Coordinating, and Controlling (Hannan et al., 2003). These processes have generally been condensed to the primary four: planning, organising, leading and controlling (Robbins, 2011). In the definition of management, two essential and related terms are efficiency and effectiveness. Generally, efficiency refers to minimising resource utilisation, and effectiveness means doing the right task to maximise goal attainment. Goal articulation is essential in infrastructure planning (Parkin & Sharma, 1999).

In management theory, planning encompasses defining goals, establishing strategies, and developing plans to coordinate activities. The organising component includes determining what tasks are to be done, who is to do them, how they are grouped, who reports to whom, and where decisions are to be made. The leading component includes motivating employees, directing the activities of others, selecting the most effective communication channel, and resolving conflicts. Finally, the controlling element monitors performance, compares with goals, and corrects any significant deviations (Ali et al., 2001; Carpenter et al., 1986; Russell W. Darnall; John M. Preston, 2010).

Here, a question arises: Are management activities universally applicable? Management theories are based on standard human behaviour. Explaining management as a generic activity, Robbins et al. (Robbins, 2011) observe that "what a manager does should be essentially the same regardless of whether he or she is a top-level executive or a first-line supervisor; in a business firm or a government agency; in a large corporation or a small business; or located in Salt Lake Kolkata, or Salt Lake City, USA."

6.1.3 State of Affairs in Watershed Management

A watershed is a complex infrastructure designed for natural resources and environmental management involving many biophysical and anthropogenic factors (Bach H et al., 2011; Conservation Ontario, 2010; Easterby-Smith & Lyles, 2003). Moreover, a watershed project is a multi-stakeholder initiative to govern water management issues collaboratively by constituting some structured stakeholder groups (State Level Nodal Agency Assam, 2008). Therefore, the watershed organisational environment is a network of groups acting as an individual managerial unit. Thus, watershed planners should know that each constituent group should define internal management functions (Daspit et al., 2013; Devine et al., 1999; Wang et al., 2016). Also, the groups are expected to finally perform as a cross-functional team with a collaborative work ethic.

The present performance of many IWMP projects shows that many pre-defined critical management functions remain unattended by organisational components, which is why the scope for better coordination remains underutilised. Two significant reasons exist: a) CBOs are largely unstructured with minimum defined functionality, and b) Allotted functions are poorly implemented.

In that context, scrutinising watershed organisational involvement is essential to studying the scope of critical management functions by watershed organisations and analysing their present state of functioning. The primary question is: What kind of management functions are the watershed organisations undertaking against what they should do? Moreover, can there be an indexing method for evaluating the managerial effectiveness of a watershed project and participant organisations? Unfortunately, there is a shortage of research regarding the adaptability of standard management functions or indexing managerial effectiveness in a watershed organisational environment.

Therefore, the present state of affairs in the management environment of an IWMP project is studied through an opinion survey among the beneficiaries. After analysing the result, an indexing system is framed to determine the effectiveness of sharing management functions amongst the watershed organisational elements and the overall managerial effectiveness of the project. The system might apply to any IWMP project to redesign the present organisational model to improve stakeholders' participation.

6.2 Methods

6.2.1 Study Area and Data Collection

After reviewing the functional management theory's applicability to watershed management, the essential management functions of an organisation are identified from the literature study, IWMP project documents, and local observations. Each IWMP project has six active organisational components: PIA, WDT, WDC, GS, SHG, and Villagers (Table 2.1). These components are supposed to undertake different management functions under four management processes or function categories: planning, organising, leading, and controlling. For examining the management functions carried out by the present watershed organisational components under IWMP, three project areas in the Brahmaputra Valley, Assam, namely, Turkunijan IWMP, Kaldia IWMP, Satpokholi IWMP (SLNA, 2010c, 2010b, 2010a, 2011b).

From the management science perspective and analysing the information obtained from IWMP theories, the present management functions in the existing watershed organisations can be summarised as in Table 6.1.

Table 6.1: The current management functions in the existing watershed organisations

Management Functions Category	**Management Functions**
Planning	A1-Defining goals
	A2-Establishing strategies for achieving goals
	A3-Developing comprehensive plans to integrate and coordinate
Organising	B1-Determining what tasks are to be done
	B2-Determining who is to do them
	B3-Determining how to group the tasks
	B4-Determining who reports to whom
	B5-Determining where decisions are to be made
Leading	C1-Motivating employees
	C2-Directing activities
	C3-Selecting effective communication channels
	C4-Resolving conflicts among members
Controlling	D1-Monitoring the performance
	D2-Comparing the results with goals
	D3-Correcting

To give a broader base to our observation, an opinion survey amongst 120 watershed beneficiaries (in each of the three studied projects) is conducted. The close-ended questionnaire had a two-point rating scale ('y' for 'yes' and 'n' for 'no'). (numerically, y=1 and n=0). The questionnaires are distributed to randomly selected stakeholders in the project area.

After summing up individual opinions, a final response table is established (Table 6.2). In the response table, management function-wise scores of each component organisation are denoted as Y or N.

Question-wise, if $\Sigma y \Rightarrow$ total 'yes' responses, R $\Rightarrow$ numbers of respondents, the final response score is Y if $(\Sigma y/R) >= 0.5$, or N, if $(\Sigma y/R) < 0.5$. Management function-wise, a 'Y' $\Rightarrow$ by the majority opinion the function is done, and 'N' $\Rightarrow$ not done. Numerically, Y=1 and N=0.

6.2.2 Organisational Involvement Index (OII)

The share of management functions an individual organisation undertakes reflects its involvement. The total involvement score by all organisations will give the present state of function-sharing. For organisation' X_i,' the OI score is OIX_i = (Total Management functions undertaken by X_i)/Total management functions allotted to X_i.

If 'm' $\Rightarrow$ numbers of organisations, the overall organisational involvement index (OII) is $OII = \Sigma OIX_i / m$, where i = 1, 2...m

6.2.3 Project Managerial Effectiveness Index (PMEI)

The number of management functions all organisations carry out will reflect the project management effectiveness. The two steps for finding PMEI are: a) finding Process-wise effectiveness index, and b) finding PMEI.

For a process' Q_i', $PEIQ_i$= (Total numbers of Qi-related management functions covered by all organisations)/ Total functions under Q_i

Therefore, PMEI = (Total Functions Covered Score in All Management Processes by all organisations)/ Numbers of Management Processes $= \Sigma PEIQ_i / N$, where 'N' $\Rightarrow$ total management processes, i = 1, 2..., N. The final result is shown as a percentage of the obtained positive score to the maximum ideal positive score. For a project 'K', watershed management index (WMI) = OII_K + $PMEI_K$. The maximum value of IWI =IWI_{max}=200.

6.3 Results and Discussion

The summarised results based on primary field data are shown in Table 6.2 (Turkunijan IWMP), 6.3 (Satpokholi IWMP) and 6.4 (Kaldia IWMP).

6.3.1 Functional Involvement of Participant Organisations (OII)

The OII, PMEI and WMI summary of the three IWMPs are shown below (Fig 6.1).

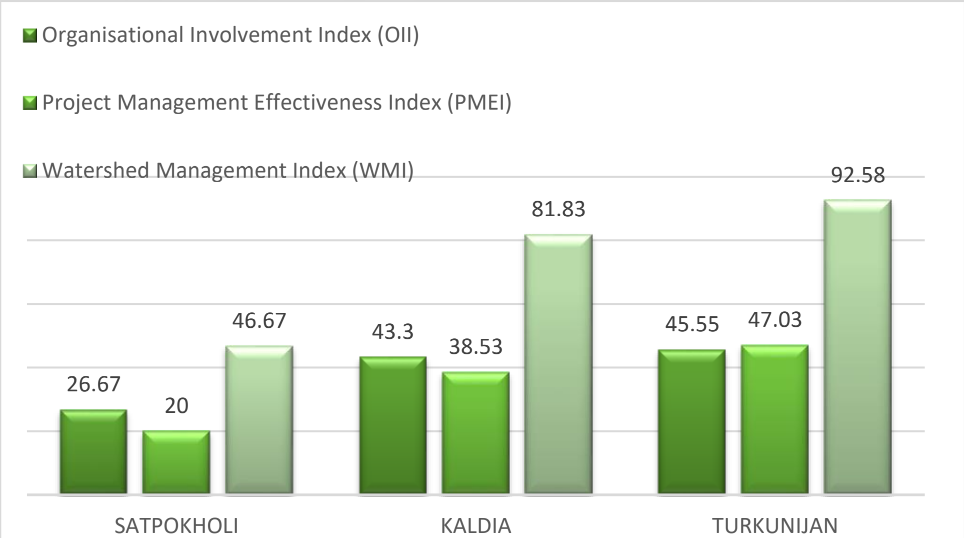


Fig. 6.1 OII, PMEI, WMI values of IWMP projects studied

Since IWMP focuses on people's participation in watershed management, a maximum number of organisations should be allotted essential management functions. In Turkunijan IWMP, the degree of organisational involvement given by the OII is only 45.55%. This value for Kaldia and Satpokholi IWMP is smaller (43.3 for Kaldia and 26.67 for Satpokholi). It means the participant organisations are either not allotted their functions share or slackness in their sides. It indicates a review of the present situation.

The result (Table 6.2, 6.3 and 6.4) shows that the PIA, the watershed developer, involves a 100% share of management functions (except it is 80% in Satpokholi IWMP). The

WDT also involves many functions (above 80%). On the other hand, the share of Gram Sabha, a statutorily elected body, is not up to mark (below 13%). Notably, the function shares decrease gradually towards community groups. Thus, a top-heavy, spinning top type of function share structure is seen in the studied projects instead of a desired square one. This structure denotes that a heavily centralised management environment is not conducive to effective collaboration.

Most surprisingly, villages and SHO groups are entangled with zero function shares. The probable reason for this may be that the planners' management scope is not well-defined, or these are not percolated to the community level. Hence, it invites stringent reengineering interventions.

6.3.2 Project Managerial Effectiveness Index (PMEI)

For effective project management, it is expected that the project should cover all the management functions under all management processes and therefore $PMEI_{max}$ =100%. However, in all the IWMPs, the PMEI values are below 50% (only 47.03% in Turkunijan, 38.53% in Kaldia and 20% in Satpokholi) (Figure 6.1).

6.3.3 Managerial Process Control (Functions category covered)

It is seen that, in Tukunijan, the functions covered in the controlling process are maximum (PEIC=55.6%) (Fig.6.2). On the other hand, it is minimal for the organising process (PEIC=36.7%), which shows that the project gives a more crucial controlling process and lesser thrust in the organising process. Practically significant project inefficiency occurs due to slackness in organising. In such a case, a more robust control thrust cannot improve the project. Surprisingly, the functions covered in the controlling process are zero in Satpokholi IWMP.

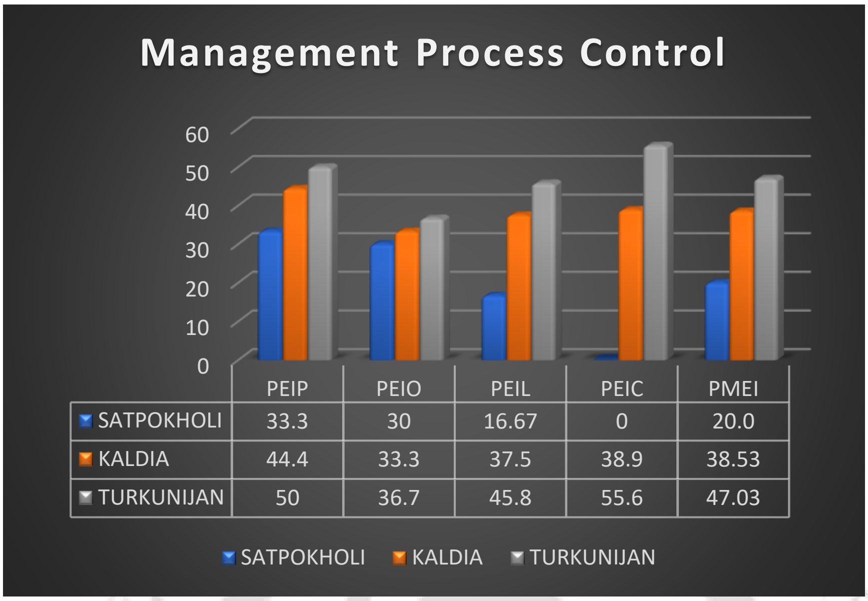


Fig. 6.2 Management process control in the projects studied

Primarily, watershed projects emphasise the participatory planning process. However, in Turkunijan, the coverage of management functions under the planning process (PEIP) is only 50 %, whereas, in Kaldia and Satpokholi, these values are 44.4% and 33.3% only).

Commonly, watershed planners often downplay the leading process. It is also confirmed from the results. At Turkunijan, the PEIL score of 45.8% is much less than expected. In Kaldia and Satpokholi, these scores are lower (37.5% and 16.67% respectively). Instead, functions under the leading process, such as conflict resolution and the selection of effective communication channels, are essential functions for a watershed project.

6.3.4 Watershed Management Indices

As defined previously, watershed project's WMI scores are the sum of their individual OII and the PMEI values. The obtained WMI values are: $WMI_{Turkunijan}$ = 92.58, WMI_{Kaldia} = 81.83, and $IWI_{Satpokholi}$ = 46.67 (while IWI_{max} = 200). They represent the overall management effectiveness as per the study objective.

Table 6.2: Summarized Response Analysis for Turkunijan IWMP

Management Functions Category	Management Functions	PIA	WDT	WDC	GS	SHG	Villagers	Function -wise Score	Management Functions Category-wise score
Planning	A1-Defining goals	Y	Y	Y	N	N	N	3/6	PEIP =9/18=50%
	A2-Establishing strategies for achieving goals	Y	Y	Y	N	N	N	3/6	
	A3-Developing comprehensive plans to integrate and coordinate	Y	Y	Y	N	N	N	3/6	
Organising	B1-Determining what tasks are to be done	Y	Y	Y	Y	N	N	4/6	PEIO =11/30 =36.7%
	B2-Determining who is to do them	Y	Y	N	N	N	N	2/6	
	B3-Determining how to group the tasks	Y	Y	N	N	N	N	2/6	
	B4-Determining who reports to whom	Y	Y	N	N	N	N	2/6	
	B5-Determining where decisions are to be made	Y	N	N	N	N	N	1/6	
Leading	C1-Motivating employees	Y	Y	N	N	N	N	2/6	PEIL =11/24 =45.8%

	C2-Directing activities	Y	Y	Y	N	N	N	3/6	
	C3-Selecting effective communication channels	Y	Y	Y	N	N	N	3/6	
	C4-Resolving conflicts among members	Y	Y	Y	N	N	N	3/6	
Controlling	D1-Monitoring the performance	Y	Y	Y	N	N	N	3/6	PEIC =10/18 =55.6%
	D2-Comparing the results with goals	Y	Y	Y	N	N	N	3/6	
	D3-Correcting	Y	Y	Y	Y	N	N	4/6	
Functions Shared Score by Component Organisations		OI_{PIA}=15/15=100%	OI_{WDT}=14/15=93.3%	OI_{WDC}=10/15=66.7%	OI_{GS}=2/15=13.3%	OI_{SHG}=0/15=0	OI_{VILL}=0/15=0	41/90	
Organisational Involvement Index (OII)	=Total Functions Shared Score/ No of Participant Organisations=(100+93.3+66.7+13.3+0+0)/6=45.55%								
Project Management Effectiveness Index (PMEI),		= Total Functions Covered Score / No of Management Processes=(50+36.7+45.8+55.6)/4=47.03%							
Watershed Management Index (WMI)		92.58							

Table 6.3: Summarized Response Analysis for Satpokholi IWMP

Management Functions Category	Management Functions	PIA	WDT	WDC	GS	SHG	Villagers	Function - wise Score	Management Functions Category-wise score
Planning	A1-Defining goals	Y	Y	N	N	N	N	2/6	PEIP =6/18=33.3%
	A2-Establishing strategies for achieving goals	Y	Y	N	N	N	N	2/6	
	A3-Developing comprehensive plans to integrate and coordinate	Y	Y	N	N	N	N	2/6	
Organising	B1-Determining what tasks are to be done	Y	Y	N	N	N	N	2/6	PEIO =9/30=30%
	B2-Determining who is to do them	Y	Y	N	N	N	N	2/6	
	B3-Determining how to group the tasks	Y	Y	N	N	N	N	2/6	

	B4-Determining who reports to whom	Y	Y	N	N	N	N	2/6	
	B5-Determining where decisions are to be made	Y	N	N	N	N	N	1/6	
Leading	C1-Motivating employees	Y	N	N	N	N	N	1/6	PEIL =4/24=16.67 %
	C2-Directing activities	Y	N	N	N	N	N	1/6	
	C3-Selecting effective communication channels	Y	N	N	N	N	N	1/6	
	C4-Resolving conflicts among members	Y	N	N	N	N	N	1/6	
Controlling	D1-Monitoring the performance	N	N	N	N	N	N	0/6	PEIC =0/18=0%
	D2-Comparing the results with goals	N	N	N	N	N	N	0/6	
	D3-Correcting	N	N	N	N	N	N	0/6	

Functions Shared Score by Component Organisations	OI_{PIA}=12/15=80 %	OI_{WDT}=12/15=80 %	OI_{WDC}=0/15=0 %	OI_{GS}=0/15=0 %	OI_{SHG}=0/15= 0	OI_{VILL}=0/15= 0	24/90	
Organisational Involvement Index (OII)	Total Functions Shared Score/ No of Participant Organisations= (80+80+0+0+0+0)/6=26.67%							
Project Management Effectiveness Index (PMEI)	Total Functions Covered Score / No of Management Processes= (33.3+30+16.67+0)/4=20%							
Watershed Management Index (WMI)	46.67							

Table 6.4: Summarized Response Analysis for Kaldia IWMP

Management Functions Category	Management Functions	PIA	WDT	WDC	GS	SHG	Villagers	Function-wise Score	Management Functions Category-wise score
Planning	A1-Defining goals	Y	Y	Y	N	N	N	3/6	PEIP =8/18=44.4%
	A2-Establishing strategies for achieving goals	Y	Y	Y	N	N	N	3/6	
	A3-Developing comprehensive plans to integrate and coordinate	Y	Y	N	N	N	N	2/6	
Organising	B1-Determining	Y	Y	N	N	N	N	2/6	PEIO =10/30=33.3%

	what tasks are to be done								
	B2-Determining who is to do them	Y	Y	N	N	N	N	2/6	
	B3-Determining how to group the tasks	Y	Y	Y	N	N	N	3/6	
	B4-Determining who reports to whom	Y	Y	N	N	N	N	2/6	
	B5-Determining where decisions are to be made	Y	N	N	N	N	N	1/6	
Leading	C1-Motivating employees	Y	N	N	N	N	N	1/6	PEIL =9/24=37.5%
	C2-Directing activities	Y	Y	N	N	N	N	2/6	
	C3-Selecting effective communication channels	Y	Y	N	Y	N	N	3/6	
	C4-Resolving conflicts among members	Y	Y	Y	N	N	N	3/6	

Controlling	D1-Monitoring the performance	Y	Y	Y	N	N	N	3/6	PEIC =7/18=38.9%
	D2-Comparing the results with goals	Y	N	N	N	N	N	1/6	
	D3-Correcting	Y	Y	N	Y	N	N	3/6	
Functions Shared Score by Component Organisations		OI_{PIA}=15/15=100%	OI_{WDT}=12/15=80%	OI_{WDC}=10/15=66.7%	OI_{GS}=2/15=13.3%	OI_{SHG}=0/15=0	OI_{VILL}=0/15=0	39/90	
Organisational Involvement Index (OII)	Total Functions Shared Score/ No of Participant Organisations= (100+80+66.7+13.3+0+0)/6=43.3%								
Project Management Effectiveness Index (PMEI)		Total Functions Covered Score / No of Management Processes= (44.4+33.3+37.5+38.9)/4=38.53%							
Watershed Management Index (WMI)		81.83							

6.4 Summary

This study assumes that the essential management functions are generic and apply to watershed management. There may be a general misconception that managing a watershed project does not suit the purview of project management theory. Due to such perception, management functions are not adequately delineated for the cluster of participant organisations. This cluster acts like a cross-functional work team with complex inter-relationship. It should not deter the applicability of management functions to participant organisational units. Instead, watershed managers can improve project efficiency by focusing on managerial deficiencies.

In watershed projects, beneficiaries are project partners. Although the planners aim to improve their livelihood, assets are primarily created in build-operate-transfer mode. So, diagnosing managerial laxity will pave the way for an appropriate intervention for better involvement and sustainability. In this regard, the proposed indexing method will be valuable for watershed managers.

The previous chapters discuss the development of indices, one for every CP-related project phase (Planning, Organising, Implementing and Management). As per the study objective, these phase-wise indices will be aggregated to obtain a combined watershed CP index. The next chapter describes the relevant methods, results and discussion related to developing an Integrated Watershed index (IWI).

Chapter 7 Developing a multi-dimensional integrated watershed index (IWI) aggregating different indices

7.1 Introduction

One of the objectives of this study was to develop a community-centred integrated index aggregating different CP-related project phase-wise indices to get a combined watershed effectiveness metric. This chapter describes how the community participation indices of different project phases are scientifically aggregated to derive an integrated watershed indexing (IWI) for measuring community participation effectiveness.

In any watershed project, policymakers must examine if the strategy formulation and content approaches of CPM adopted by project-level watershed organisations are conducive to improved service performance. In the watershed project cycle, a community can participate in different operational phases: planning, organising, implementing and managing. In this study, community participation is evaluated at these phases, and four indices (WPDI, CPI, PI and WMI), one for each phase, are developed as described in the previous chapters.

Here, a question may arise: Why should indices be integrated?

Contextually, the existing literature on strategy formulation and content and developing hypotheses on their relationship with organisational performance are explored. A description of methods, data and measures will follow this. The statistical analysis results will be presented before the findings are considered and conclusions drawn.

As part of developing IWI, one must consider the impacts of various watershed stressors related to CP. An integrated index ultimately leads to better management decisions that help set priorities, pool limited resources and increase participant efficiency.

Multi-dimensional measures (often termed composite indicators) are popular tools in the public discourse for assessing the performance of countries on human development, perceived corruption, innovation, competitiveness, or other complex phenomena (Becker et al., 2015). An aggregated or integrated index is also called a composite index. Composite Indicators (CIs, a.k.a. indices) are increasingly used as they can simplify the interpretation of results by condensing the information of a plurality of underlying indicators in a single measure (Lindén et al., 2021). The fundamental concept of a CI is condensing information with utmost care to maximise information transfer from individual indices to the CI.

Indices aggregation is the operation of combining multiple indices into one value without losing any information. In this study, the IWI is based on the principle that community participation is entangled with more than one dimension of the watershed development programme. One or two of these dimensions cannot wholly compensate for determining the state of operationalisation of CP. So, the IWI aggregates sub-indices that are simple combinations of observable and measurable indicators.

This study's basic logic behind the IWI is derived from the literature review and the basic definition of partnership (Ref: The American Heritage Dictionary, https://ahdictionary.com/word/search.html?q=partnership). In this definition, the most critical points are a specified goal, cooperation and responsibility (Fig. 7.1).

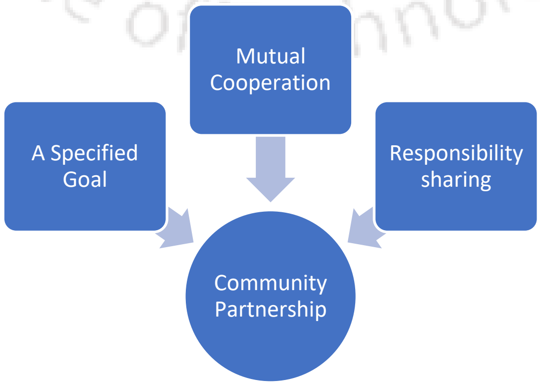


Fig. 7.1 Three pillars of community partnership

Constructing a composite indicator requires several choices; it involves several steps in which the developer must decide which variables to include in the composite index and how to aggregate them (Becker et al., 2015). In this study, the four derived indices represent four pillars of watershed CP, as shown below (Table 7.1 and Fig. 7.2).

Table 7.1: The derived indices corresponding to the pillars of watershed CP

Community Participation Pillars	***Relevant Watershed Project Operations***	***Related Index Developed***	***Intended to evaluate***
A specified goal	Planning	WPDI	Project desirability
Mutual Cooperation in organising	Organising	CPI	CP effectiveness
Mutual Cooperation in implementing	Implementing	PI	Project Performance
Responsibility Sharing	Managing	WMI	Managerial effectiveness

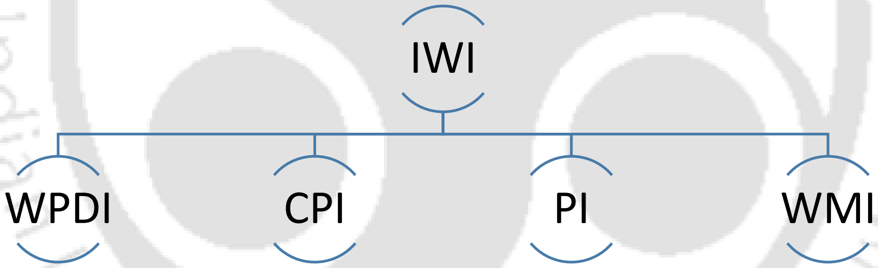


Fig. 7.2 The integrated index and its components

7.2 Methods

7.2.1 Development of IWI

An essential question in developing an integrated index is: What kind of mean is adaptable to reflect the central tendency or, so to say, an aggregated effect of different sub-indices?

The 'Consumer Price Index Manual: Theory and Practice' (International Labour Organisation, 2021) mentions that the best symmetric averaging of two indices for the theoretical Consumer Price Index can be obtained by taking the geometric mean of individual indices rather than by arithmetic mean (International Monetary Fund, 2021). The Human Development Index (HDI) is a summary measure of achievements in three critical dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living. The HDI is each dimension's geometric mean of normalised indices (United Nations Development Programmes, 2023). The selection of these three specific dimensions and the choice of constructing the index by giving these dimensions equal importance are normative. Thus, composite indicators are usually constructed with normative assumptions in variable selection and weighting (Paruolo et al., 2013). Here, 'normative' is understood to be 'related to and dependent on a system of norms and values.

To provide information to development agencies and others studying food, energy, and water resources, the RAND Corporation developed a global Pardee RAND Food-Energy-Water Security Index (FEW Index). The FEW Index comprises three sub-indices—one for food, energy, and water—and combines these sub-indices using an unweighted geometric mean (Willis et al., 2016).

Since the integrated index is comprised of four sub-indices, one each for project desirability, performance, effectiveness of CP and managerial effectiveness, the sub-indices are aggregated by using an unweighted, geometric mean:

The IWI = $\sqrt[4]{WPDI \times CPI \times PI \times WMI}$

Here, the use of geometric mean seems appropriate in integrating sub-indices. The G.M. is preferable due to the advantages shown in points 5, 7, and 8 of Table 2.3.

As far as weighting is concerned, as a rule, their developers set weights in a composite indicator to add up to one. In this study, equal weights are assigned to each component indices, with the modelling assumption that the trade-offs between each one included in the IWI should be equal. A common practice in composite indicator construction is to set the weights of each input variable to be equal to make each input variable contribute equally to the value of the composite indicator. This is usually done because choosing weights other than equal would impose questionable assumptions on the relative importance of each variable (Becker et al., 2015). In this study, the resulting information transfer under the aggregation is equal.

7.2.2 Validity Check

An integrated index would be meaningful only if the IWI positively correlates with the individual component indices. This is because the IWI and the components concur to describe a unique latent phenomenon. In this study, the validity of the IWI can be checked by the sensitivity analysis methods discussed in the following paragraphs.

Paruolo et al. propose a methodology based on nonlinear regression (Paruolo et al., 2013). It compares the assigned weights with an ex-post measure of importance – in this case, Karl Pearson’s correlation ratio (also known as the first-order sensitivity index), which is a coefficient of nonlinear association. It is found that the structure of the dataset and correlations between the indicators often have a decisive effect on each indicator’s influence on the index (Lindén et al., 2021).

As it is customarily performed in physical sciences and engineering, sensitivity analysis is concerned with analysing the effects of uncertainty in model input variables on the model output.

On the other hand, the “sensitivity analysis” referred to in this study does not deal with uncertainty in the inputs of a composite indicator. Instead, it quantifies the contribution of each input to the composite indicator as a result of the weight and aggregation of the indicator and the distribution and inter-dependence of each input variable by measuring the nonlinear dependence of the composite indicator on each of its input variables (Becker et al., 2015).

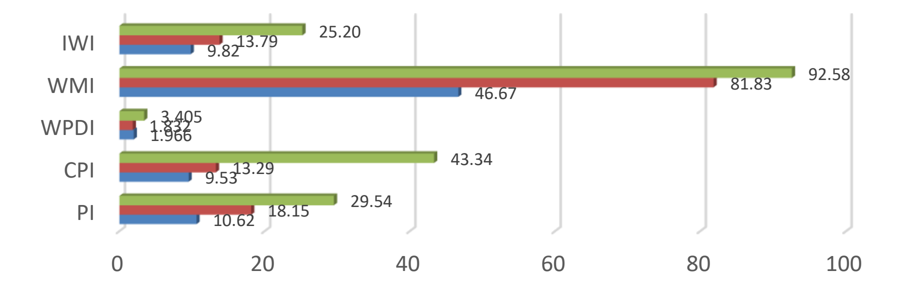
For this study, it can be summarized that the strong positive association between different sets of individual indices with the set of IWI values is essential for accepting the aggregation method. The Pearson correlation coefficient can show this. This is also called the measure of dependence (Becker et al., 2015) of IWI on each index.

Thus, the measures of dependence of the IWI on its input variables are r_i = Corr (x_i, y): correlation, where y refers to the IWI and x_i to the individual indices.

7.2.3 Limitations

One limitation of this IWI is that it does not set any maximum or minimum values (goalpost) or cut-off points (like very high, high, low, etc.) for the watershed projects. So, the standardisation of IWI values may be a part of future study.

7.3 Results and Discussion



	PI	CPI	WPDI	WMI	IWI
Tur	29.54	43.34	3.405	92.58	25.20
Kal	18.15	13.29	1.832	81.83	13.79
Sat	10.62	9.53	1.966	46.67	9.82

Tur Kal Sat

Fig. 7.3 Values of IWI and individual indices for the studied

The results of IWI calculations for three selected IWMP projects (Kaldia, Satpokholi and Turkunijan) are shown in Fig. 7.3. The maximum value of IWI for a project can be 195.41 (Since WPDImax=729, CPImax=100, PImax=100 and WMImax=200).

The strong positive association ($0.5<r<1.0 \Rightarrow$ Large Association) between different sets of individual indices with the set of IWI values is observed from the Pearson correlation coefficient (Table 7.2). This is the measure of dependence (Becker et al., 2015) of IWI on each component index.

Table 7.2: The measure of dependence of IWI on individual indices

Indices	*The measure of dependence*
PI-IWI	0.988008
WMI-IWI	0.841841
WPDI-IWI	0.946613
CPI-IWI	0.988816

The correlation values are pretty within the acceptable limit for further procedures of IWI development (A significant association is assumed if the Pearson Coefficient is $05<r<1.0$) (Laerd Statistics, 2018). Edgeworth observed that the answer to the question of what is the Mean of a given set of magnitudes cannot, in general, be found, unless there is also given the object for the sake of which a mean value is required." (Edgeworth, 1888). Summarising, the aggregation of indices in this study can be illustrated in Fig. 7.4.

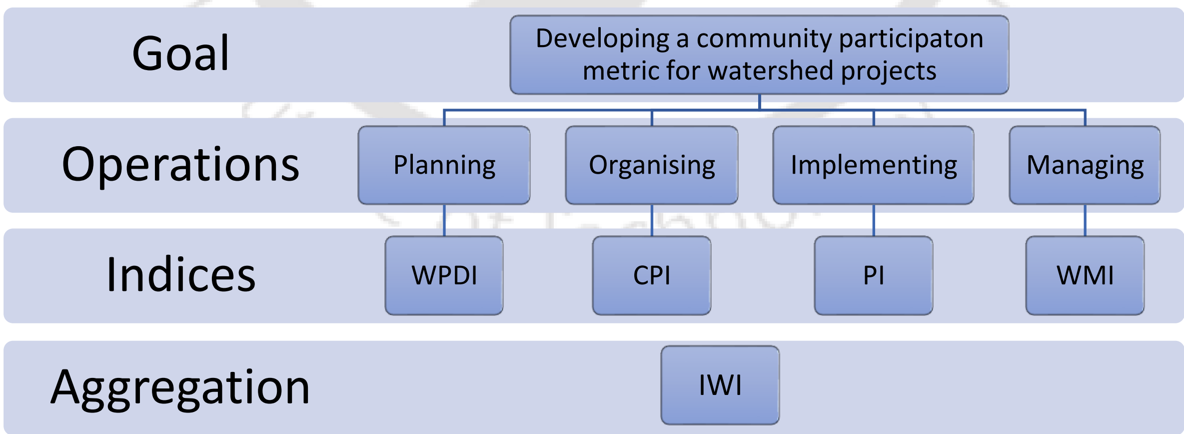


Fig. 7.4 Summarised aggregation process

7.4 Summary

The IWI is a summary measure of achievements in four key dimensions of community participation in watershed projects: planning, organising, implementing, and managing. The IWI is the geometric mean of normalised indices for each dimension.

The information provided by the IWI would be an exciting tool for conveying the state of affairs of the CPM in different dimensions of a watershed project.

Finally, the current findings should not be generalised and applied. Still, the broader applicability of the proposed tools requires additional testing with different datasets, varying watershed projects and alternatives, and further normalisation and aggregation functions. The work of setting goalpost values and cut-off levels for watershed projects in analogous settings is a future recommendation.

The previous chapters discuss the development of watershed CP indices for different project phases. The next chapter presents overall conclusions, essential contributions and recommendations for future works related to this research.

Chapter 8 Conclusions and future study

8.1 Study aim, gap and objectives

This research aims to develop community-centred evaluation frameworks and indices for enhancing effective participation in watershed projects operationalised on IWRM and IWMP protocols. Since watershed programmes are grounded on a multi-stakeholder collaborative approach with community-based organisations as principal participants, watershed success positively correlates with the effectiveness of the community participation mechanism adopted at the project level. Therefore, it is imperative to examine what contributes to the effectiveness of watershed projects from the corresponding views of the watershed managers and the involved community.

However, it is hard to meaningfully examine the community's perceptions of the project deliverables in practice. There are several reasons for this. First, the watershed programmes are propagated in line with the most generalised protocols like IWRM, FAO, IWMP and PMKSY through the government and local non-government community-based organisations (CBO), where every stakeholder group can define success. The lack of coordination and authority sharing makes smaller groups insignificant. Consequently, despite what is envisioned in the institutional mapping of project-level watershed organisations, CBOs disengage themselves from the watershed mission. Second, there is little usefully disaggregated data on project performance, and there are limitations even on what is available at the project level. Usually, project performance is monitored and evaluated in a centralised, top-down approach by the number of assets created and funds used. No such data is available at the community level to fathom community perceptions and any disparity of stakeholders' opinions, even if community members are the most able to make informed assessments.

In such a situation, where watershed projects are being delivered in a more prescribed way where the outcomes were defined and directly observable without taking into account the community-level impact, this approach seemed unlikely to yield valuable results, as compared to looking at community perceptions of project outcome and users' accountability. Contextually, examining the dimensions and characteristics of community participation in watershed programmes and designing a set of participatory evaluation frameworks to explore these issues is essential.

The research hypothesis was that a community-centred metric could be developed to evaluate watershed effectiveness by integrating indices constructed on stakeholders' desirability, degree of participation, organisational effectiveness, and participatory performance indexing.

8.2 Summary of research findings

The key findings of the research are presented in the following sub-sections.

8.2.1 Watershed Project Desirability Index

Pursuing a vital watershed management question, 'How can local people get involved in the complexities of planning, designing and managing the water resource issues?', this study examines stakeholders' desirability about the planned watershed parameters to develop an indexing method for harmonising community participation.

The developed framework has the potential to filter the parameters by cross-examining two vital attributes: rank and stakeholders' aggregability. The findings show that in every project, some parameters have acceptable rank but unacceptable aggregability. Those parameters having acceptable rank and aggregability only are considered desirable for estimating the watershed project desirability index (WPDI). This has made the indexing method robust. The WPDI of Satpokholi, Kaldia and Turkunijan IWMP projects are 1.966, 1.831 and 3.406, respectively ($WPDI_{max}$=729). These results substantially reveal critical misalignments of stakeholders' perceptions regarding the planned parameters of the studied watershed projects. The degree of misalignment could also be quantified to present a measurable state of affairs in watershed projects. The congruency of inter-group perceptions regarding the subdomains for Satpokholi, Kaldia and Turkunijan projects is 1.37%, 0.01% and 1.85%, respectively (Max CIP_{SD}=100%).

The findings also reveal that the framework will be a worthy tool to compare the effectiveness of different watershed projects regarding community participation in project planning. As the methodology is based on a participatory approach, the indexing procedure helps promote an environment that improves social learning and understanding of the water system, encouraging the exchange of knowledge and best management practices.

8.2.2 Community Participation Index

This study attempted to understand the critical determinant of community strength and how to increase the community's confidence and capacity to play a prime role in socio-economic activity by exercising increased choice and control over the resources in the watershed zone.

This methodology has generated a well-accepted CPEF, with stakeholders' agreement at 80% (Section 4.4.1.3). Applying this framework to the Kaldia, Satpokholi and Turkunijan IWMP, the obtained community participation indices are 13.29%, 9.53% and 43.34%, respectively. It indicates that the community participation mechanism in Turkunijan was the most effective compared to the other two projects. The survey has four score levels (Score 0, 1, 2 and 3) that the respondents can choose. This response percentage on different scores can reveal some vital indications of community participation insufficiencies. In Satpokholi IWMP, with the lowest CPI score, 81.25 % of the respondents marked zero scores, and only 3.81 % chose the highest score, 3, for the questions. This shows a high degree of dissatisfaction with the project CPM. In comparison, Turkunijan IWMP has the highest CPI (43.34%) and the highest response percentage (12.83%) for scores 3. 0, 1 and 2, which show an almost equal percentage response. Similarly, in Kaldia IWMP, where CPI has the second highest value (13.29%), a large percentage of respondents (68.61%) have chosen zero scores and a very meagre 0.23% of respondents have selected a score of 3.

Results infer that despite an awareness of their rights and sense of roles and responsibilities, in most of the projects, community members lack adequate information about the collaborative intents and objectives of the watershed policies; communities do not have access to training for communicating their priorities, exercising their rights and ensuring accountability within the watershed programme. They lack the financial and accounting knowledge to use the available resources for economic sustainability. The weakness of monitoring and supervision within the government watershed system and the lack of effective sanctions over poorly performing organisational units or members limit the effectiveness and responsiveness to the project deliverables. In some instances (as in Turkunijan IWMP), management appears somewhat stronger in using the prescribed organisational structures where they are available.

In most cases, a proper mode of selecting or electing members of Water Users' Groups and Self-Help Groups limits the prospects. The higher-level participant organisations (Gram Sabha, WDC and WDT) could be more assertive in enforcing inter-organisational cooperation, training and systematic follow-up procedures. In Kaldia IWMP, community members are not in agreement with the project planners regarding the following: i) the number of villages covered in the project, ii) the development of fisheries, iii) financial aspects and economic potential of the project goals, iv) prevention of long-standing problem of severe water logging, v) tree plantation, weakness in monitoring and supervision by authorities and vi) associating community members to the project planning. They are also sceptical about the channel of accountability and responsiveness of the watershed functionaries and CBO members. Here, community members' agreement regarding different sub-domains ranges from the highest 18.06% to the lowest 7.41%.

The community perceptions about watershed project effectiveness could be much better in Satpokholi IWMP (CPI 9.53%). Many community members strongly agree that the project functionaries have undermined the community links. Here, community members' agreement regarding different sub-domains ranges from the highest 19.11% to the lowest 5.75%. In comparison, the community members in Turkunijan IWMP have a better perception regarding the participatory actions of the project (43.34%). Here, community members' agreement regarding different sub-domains ranges from the highest 58.68% to the lowest 33.17%. Majority of the community members have felt the lack of i) adequate check dam construction, ii) soil erosion prevention, iii) tree plantation, iv) livestock development, v) fisheries development, vi) protection of historical places, vii) sustainable economic planning and fund availability.

Thus, accommodation of appraisal indicators from a participatory or bottom-up perspective, this methodology facilitates continuous & comprehensive evaluation of CP efforts in participatory mode – unlike any top-down monitoring procedure could do,

8.2.3 Watershed Management Index

Pursuing the objective of this study for developing a framework to evaluate the managerial effectiveness of the project-level watershed organisations, two indexing methods were developed: a) A Project Management Effectiveness Index (PMEI) to gauge the degree of overall managerial effectiveness of a watershed project by measuring what management functions covered in the project, and b) An Organizational Involvement Index (OII), to gauge the degree of managerial involvement of various participant organisations, by measuring the number of management functions performed by all organisational elements.

Although watershed governance focuses on participatory development, the studied watershed projects do not propagate collaborative procedures amongst the participant organisations. While comparing the three IWMPs, the organisational involvement index in Turkunijan IWMP is the highest (45.5%) and the lowest in Satpokholi IWMP. In Kaldia IWMP the OII is 43.3%. The results indicate that participant organisations are not adequately imparted with a proper share of required managerial functions. One primary reason is the lack of inter-organisational coordination and dissemination of organisational knowledge to participant organisations. The weak community involvement in watershed projects is mainly exemplified by the fact that, in all the projects, the OII of SHGs and WUG (or Villagers' groups) are zero, and OIIs of higher-level organisations like Project Implementation Agency (PIAs) and WDT are very high (80 to 100%). This shows a table-top type organisational functions sharing practice amongst the participant organisations that can slow down their willingness to continue.

Similarly, the PMEI, which tells about the organisation's managerial functions, is also at a medium to low level. The PMEIs in Turkunijan, Kaldia, and Satpokholi are 47.03%, 38.53%, and 20%, respectively. The standard management functions covered in the watershed organisations should also be better than at present. It's surprising to note that, despite the PIA being the highest-level participant organisation, it covers only equal to or below 50% of standard management functions. A significant reason for these low values may be the non-induction of management ethics to watershed protocols and the absence of project-level monitoring and evaluation procedures to determine management effectiveness. The combined results of OIIs and PMEIs are denoted as the WMI, which could be effectively used as an integrated management index.

Thus, the management function indexing system will help the watershed planners track and compare the management environment at different points of time or compare the functional status of various projects. In addition, it will help policymakers and watershed managers introduce new management etiquette in the watershed management space by designing suitable interventions for the management process reengineering for more congruent function sharing.

8.2.4 Performance Index

Pursuing the question, "How can we assess the IWMP project performance from the perspective of the users' community?" one objective of this study was to construct a performance indexing framework (PEF) for watershed projects and to validate existing project areas. Accordingly, three IWMP projects in Brahmaputra Valley, Assam (India) developed and validated a framework.

Results show that the framework has the potential to quantify project performance. The performance indices (PI) indicate that Turkunijan IWMP has the best performance score (29.54%), while the Kaldia and Satpokholi IWMPs are in second (PI 18.15%) and third places (PI 10.62%), respectively. Besides, the framework could be used to determine goal-wise and goal-category-wise performance scores. Most importantly, it is evident that the social capital development category is the highest-performing category among all the IWMPs. Conversely, 'Associated Infrastructure Development" is the least-performing category in Turkunijan and Satpokholi IWMP, while "Naturalization and Afforestation" is the least-performing category. Some other beneficial information is also obtained by applying the framework. One of them is the percentage of zero score (PZS). The PZS values tallies with the PI values. For example, the PZS of Satpokholi is the highest (88.50%), indicating its low performance, as inferred by its PI. Similarly, the PZS of Turkunijan (36%) indicates its good performance, tallying with the inference given by its PI. Besides these, watershed managers can also get category-wise PZS to determine each category's comparative performance.

This PEF would fill the requirement of a handy evaluation tool for bottom-up performance evaluation in watershed projects. Policy-makers may assign goalposts or limiting values of the Disparity Squared to compare periodic project performance and remodelling.

8.2.5 Integrated Watershed Index

To comply with this study's final objective of this study an integrated watershed index (IWI) for CP assessment is developed by aggregating the four different CP indices (WPDI, CPI, PI and WMI) formulated for each watershed operational area involving community support. In a watershed project, the IWI value summarises information on the present state of affairs in the community participation mechanism propagated by the watershed managers.

Table 8.1: Participation Matrix

Project operations concerning CP	*Form of participation*	*Variables grounded on*	*Developed frameworks*	*Aggregation of Indices for an IWI*
Policy Design, Planning	Participating in policy decisions	Literature, protocols and project reports	Watershed project desirability index (WPDI)	IWI developed
Organising	Participating in different organisational actions	Organisational actions	CP index (CPI)	
Managing	Involving in managerial functions	Management functions	Watershed management index (WMI)	
Service delivery/Programme outcomes	Participating in performance monitoring,	Planned goals	Performance index (PI)	

Results show that Turkunijan IWMP has the highest IWI (25.20), indicating better effectiveness of community participation actions. In Kaldia and Satpokholi IWMP, IWI values are 13.79 and 9.82, respectively, meaning their community participation scenario. For the three studied projects, the IWI values strongly correlate with the values of the different indices, implying that IWI is strongly associated with indices. It proves that the IWI can be a sensitive community participation evaluation metric to accomplish the study objective.

The identified indicators cover a wide range of important watershed issues, such as quality and availability, and essential participation aspects, such as coordination capacity, conflict resolution capacity, and culture.

8.3 Key contribution of the research

The research approach is grounded on the theoretical perspective that, rather than applying a top-down approach for evaluating stakeholders' participation, it is better to relate the overall community perceptions to the different phases of the policy process. Such an approach, based on empirical study and participatory style, could appropriately evaluate and improve participation and effectiveness in watershed projects while advancing knowledge in the emerging field of governance assessment.

The proposed two-phase analytical method first identifies the variables in watershed project operations involving community participation. Then, it approximates a metric through the integrated watershed index (IWI) framework, which evaluates effectiveness based on policymakers' planned objectives and ongoing processes at the project level.

Although community participation guidelines and prescribed structures exist, many efforts to foster involvement through CBO programmes create expectations that cannot be sustained and risk undermining watershed success through community participation. This study has established the possibility for evaluating community participation in watershed programmes, mainly to strengthen effectiveness (both through providing more community information about operationalised projects and the use of resources) and to ensure more accurate responses to stakeholders' non-alignment of perceptions about project outcomes. The findings from the field study — together with a broader perspective on lessons from experiences of accomplishing watershed effectiveness offer the following set of deliverables to assess and strengthen community participation in the watershed programmes:

- The participation analysis using the proposed framework might be a standard part of the programme design and evaluation process in improving the community's willingness to continue and watershed functionaries' accountability. At the very minimum, queries about perception and feedback should be gathered and addressed using a more systematic and comprehensive approach than is usually the case.
- Enhancing participation in planning necessitates (i) provision of implementing watershed project desirability indexing to find out the non-alignment of stakeholders' preferences and (ii) adequate training about role allocation and accountability.
- Using the developed CPI methods, CBOs' support might be prudently designed to emphasise community participation and ownership, build collaborative attitudes, disseminate organisational behaviour and formalities, and avoid a situation where the objectives of programmes imparted to communities may not contest the communities' objectives.
- Adopting the WMI framework, modern management concepts might be introduced in watershed management with proper support. Effective participation is expected to be ingrained in existing participant organisations, networks, and organisational management's formal structures. Organisational functions and procedures outside these will generally be slack and unsustainable. Poorly designed management functions and authority sharing may propagate discouragement in the participant organisations.
- The PI methodology might be applied to improve the effectiveness and accountability of watershed performance provision, which requires strengthened community support (supervision, monitoring, and community feedback) within the performance evaluation system for periodical checks through the monitoring functionaries to introduce suitable interventions.

Based on this research, the following strategies might be straightaway applied to improve community participation in operating watershed projects:

1. Testing the developed frameworks in a few operationalised projects in the Brahmaputra Valley.

2. Given that the government of many countries, including the Government of India is engaged in developing policies or guidelines for community participation in watershed programmes, these frameworks might, if applied in their current or an adapted form, provide valuable and quantifiable community information for the betterment of planning, managing, organising and evaluating watershed performance.

3. Applying in-depth evaluation and reliable participatory monitoring ethics to provide constant feedback.

4. Training of a core cadre of facilitators, who could be pivotal to successful community-based interventions, to form a cross-functional group for monitoring project effectiveness

5. Periodic review of organisational cultures along with introducing stricter formality and accountability in the institutional environment.

6. Converge top-down monitoring and evaluation (with GIS and other technologies) with bottom-up feedback and reporting in a manner sensitive to the socioeconomic context and culture in the long-term horizon.

8.4 Recommendations for Future Works

With its related sets of custom indicators, the proposed CP evaluation methodology opens up many areas for future research. Some of them are given below.

1. Other more disaggregated watershed governance objectives about CP can be evaluated by adequately modifying the indicators designed for this study. Some of them may be: i) Organisational components' efficiency (both overall or project

domain-wise), ii) Assessing convergence of socio-economic developmental programmes, and iii) Assessing gender participation and women empowerment

2. The current findings can be generalised and applied with proper standardisation. Broader applicability of the proposed tools requires additional testing with a larger sample size, different datasets, and a more significant number of watershed projects and alternatives to accomplish further normalisation and aggregation functions. The work of setting goalpost values and cut-off levels to the indices for comparison and ranking of watershed projects is a future recommendation.

3. Additionally, future research is not restricted to watershed governance participation. Besides contributing to watershed management, the developed methodology might be valuable in exploring specific aspects of the problem diagnosis and goal articulations in other socio-economic endeavours where stakeholders' perceptions are diverse. Grounded on the general applicability of the methodology, researchers and policymakers might apply a similar approach to indexing developmental programmes like public health, public-private partnerships, rural and urban development, cooperation building, etc.

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Appendices

Appendix A3.1: Watershed parameters list

Domains	Sub-domains	Operational Areas/ Variables/Indicators
Domain1: LAND USE/ MORPHOLOGY	Open Space Management	P1-L1-a: Open Space- Non-agricultural
		P2-L1-b: Open Space- Agricultural
		P3-L1-c: Open Space- Agricultural Cropland
		P4-L1-d: Open Space- Agricultural Rangeland
		P5-L1-e: Open Space- Parkland
		P6-L1-f: Open Space- Forested
		P7-L1-g: Open Space- Undeveloped/ Idle land
	Plotted Land Management	P8-L2-a: Residential land
		P9-L2-b: Commercial land
		P10-L2-c: Industrial land
		P11-L2-d: Townhouses
		P12-L2-e: Roads and Highways
	Physical Land-Water Interactions and Prevention of Extreme Situations	P13-L3-a: Soil Erosion
		P14-L3-b: Landslides
		P15-L3-c: Siltation of Reservoirs
		P16-L3-d: Siltation of Cropping Field
		P17-L3-e: Stormwater management
		P18-L3-f: Drainage system
		P19-L3-g: Flood Occurrence
		P20-L3-h: Flood Damage
		P21-L3-i: Drought Management
		P22-L3-j: Loss of soil Fertility
		P23-L3-k: Soil Moisture Content
		P24-L3-l: Sediment Production
		P25-L3-m: Land pollution
		P26-L3-n: Soil feature Degradation
Domain2: WATER QUALITY & QUANTITY/USE	Water Quantity	P27-W1-a: Stream flow
		P28-W1-b: Ground Water Level
		P29-W1-c: Water Logging
		P30-W1-d: Spread of water bodies (Ponds/ wells/ springs)
		P31-W1-e: Rejuvenation of water bodies (New)
		P32-W1-f: Water Harvesting
	Water Supply	P33-W2-a: Potable Water Supply- Public
		P34-W2-b: Potable water Supply- Private
		P35-W2-c: Industrial water Supply
		P36-W2-d: Agricultural water supply- Irrigation
		P37-W2-e: Agricultural water supply- Livestock
		P38-W2-f: Agricultural water supply- Aquaculture
	Flood Management	P39-W3-a: Flood Control- Dams
		P40-W3-b: Flood Control- Levee

		P41-W3-c: Flood Control- Reservoirs
		P42-W3-d: Flood Control- Channel protection
	Hydroelectric Power	P43-W4-a: Hydroelectric Power- Impoundment
		P44-W4-b: Hydroelectric Power- Dam
		P45-W4-c Hydroelectric Power- Pumping
	Navigation	P46-W5-a: Navigation- Recreational
		P47-W5-b: Navigation- Commercial shipping
		P48-W5-c: Navigation- Commercial
	Mining	P49-W6-a: Mining- Quarrying
		P50-W6-b: Mining- Ore milling & crushing
	Water based Recreation	P51-W7-a: Water-Based Recreation- Fishing
		P52-W7-b: Water-Based Recreation- Swimming
		P53-W7-c: Water-Based Recreation- Boating
		P54-W7-d: Water Based Recreation- Picnicking
		P55-W7-e: Water-Based Recreation- Nature aesthetics
		P56-W7-f: Water-Based Recreation- Bird watching
		P57-W7-g: Water-Based Recreation- Golf course
	Water Quality - Physical	P58-W8-a: Water quality- Physical (Overall)
		P59-W8-b: Water quality- Clarity
		P60-W8-c: Water quality- Suspended sediment
		P61-W8-d: Water quality- Conductivity
		P62-W8-e: Water quality- Hardness
		P63-W8-f: Water quality- Temperature
		P64-W8-g: Water quality-Aesthetics
	Water Quality - Biological	P65-W9-a: Water quality- Biological- Bacteria
		P66-W9-b: Water quality- Biological- Parasites
	Water Quality - Chemical	P67-W10-a: Water quality- Chemical- Dissolved oxygen
		P68-W10-b: Water quality- Chemical- Nutrients
		P69-W10-c: Water quality- Chemical- Metals/ Salts
		P70-W10-d: Water quality- Chemical- Trace elements (DDT/ Chlorine)
		P71-W10-e: Water quality- Chemical
	Water Treatment	P72-W11-a: Water treatment- Filtration
		P73-W11-b: Water treatment- Chemicals tested (Iron/Arsenic/ Fluoride)
		P74-W11-c: Water treatment- Testing Facility
Domain3: PRODUCTION or ECONOMIC ACTIVITIES	Crop Production	P75-P1-a: Level of Production
		P76-P1-b: Fallow & wasteland brought under cultivation
		P77-P1-c: Area under irrigation
		P78-P1-d: Area under micro-irrigation
		P79-P1-e: Area under HYV cropping
		P80-PI-f: Market Support/ Eco centres
		P81-P1-g: Cooperative activities
		P82-P1-h: Price Support

		P83-P1-i: Off Farm Facilities
		P84-P1-j: Export/ Import Facility
		P85-P1-k: Use of new technology
		P86-P1-l: Local innovations
		P87-P1-m: Cropping Pattern
		P88-P1-n: Cash crop production
		P89-P1-o: Vegetable production
		P90-P1-p: Cropping Intensity/ Land productivity
		P91-P1-q: Crop selection for maximum nutritional uptake
		P92-P1-r: Crop failure protection
	Economic Audit	P93-P2-a: Number of families with positive income
		P94-P2-b: Average employment days
		P95-P2-c: Maximising Combined Income
		P96-P2-d: Households with Stable Income
		P97-P2-e: Maintenance of financial disciplines
		P98-P2-f: Employment Opportunity
		P99-P2-g: Self-employment opportunity
		P100-P2-h: Unproductive Employment
	Livestock	P101-P3-a: Livestock production
		P102-P3-b: Number of Livestock owners adopting artificial insemination
		P103-P3-c: Adoption of Apiculture
		P104-P3-d: Adoption of Pisciculture
		P105-P3-e: Adoption of Milk Production
	Population Migration	P106-P4-a: Population Migration- Inward
		P107-P4-b: Population Migration- Outward
		P108-P4-c: Distress migration
	Critical Planning (or budgeting) for Production Areas	P109-P5-a: Critical area planning -Agricultural
		P110-P5-b: Critical area planning -Livestock
		P111-P5-c: Critical area planning -Aquaculture
		P112-P5-d: Critical area planning -Industry
		P113-P5-e: Area under cultivated fodder
		P114-P5-f: Strip cropping/ terracing
		P115-P5-g: Cover cropping
		P116-P5-h: Range management
		P117-P5-i: Integrated pest control
Domain4: FOREST or NATURAL LANDSCAPES	Status Assessment/Action	P118-F1-a: Soil damage by deforestation
		P119-F1-b: Forest Destruction
		P120-F1-c: Temperature rise due to deforestation
		P121-F1-d: Green House Gas Emission
		P122-F1-e: Cutting of unripe Trees
		P123-F1-f: Forest Fire occurrences
		P124-F1-g: Loss of Flora and Fauna
		P125-F1-h: Number of families engaged in agroforestry
		P126-F1-i: Number of rich species- flora

		P127-F1-j: Number of rich species- fauna
		P128-F1-k: Area under grassland
		P129-F1-l: Number of types of animals
		P130-F1-m: Number of types of plants
Domain5: ENERGY	Status Assessment/Awareness	P131-E1-a: Energy/Fuel Waste
		P132-E1-b: Loss of Power Generation
		P133-E1-c: Use of alternative/ new Energy Source
		P-134-E1-d: Energy Conservation efforts
Domain6: SOCIO-CULTURAL ACTIONS	Impact on Education	P135-S1-a: Literacy
		P136-S1-b: School dropout
		P137-S1-c: Girl's education
	Status of Community Actions	P138-S2-a: Poverty Alleviation
		P139-S2-b: Disorganised Labour Force
		P140-S2-c: Child Marriage
		P141-S2-d: Gender equality
		P142-S2-e: Women's empowerment
		P143-S2-f: Youth Empowerment
		P144-S2-g: Socio-cultural cohesion
		P145-S2-h: Unscientific Behaviour/ Loss of Civility
		P146-S2-i: Lack of Cooperation
		P147-S2-j: Labour Problem
		P148-S2-k: S10-Defined Property Rights
		P149-S2-l: Alienation
		P150-S2-m: Equitable Resource Distribution
		P151-S2-n: Institutional Anarchy
		P152-S2-o: Number of social audit
		P153-S2-p: Number of community assets created
		P154-S2-q: Number of private assets created
	Community engagement Assessment	P155-S3-a: Number of CBOs linked
		P156-S3-b: Number of SHGs linked
		P157-S3-c: Number of WTCGs linked
		P158-S3-d: Number of Gram Sabhas linked
		P159-S3-e: Protection of valued features
		P160-S3-f: Community action
		P161-S3-g: Human Environment Interdependence
		P162-S3-h: Joint (Public & Private) Management
		P163-S3-i: Community Management
Domain7: ENVIRONMENTAL ACTIVITIES	Impact Assessment	P164-V1-a: Protection of aquatic and wetland habitat
		P165-V1-b: Ecological balance
		P166-V1-c: Precipitation measurement
		P167-V1-d: Meteorological measurement
		P168-V1-e: Web-based weather service
		P169-V1-f: Ambient solar radiation
		P170-V1-g: Pollution control
		P171-V1-h: Excessive use of surface water
		P172-V1-i: Excessive use of groundwater

		P173-V1-j: Eco Park development
		P174-V1-k: Waterborne commerce
		P175-V1-l: Temperature rise
		P176-V1-m: Greenhouse gas emission
		P177-V1-n: No of types of animal species
		P178-V1-o: No of types of plant species
		P179-V1-p: No of individuals of each species
		P180-V1-q: Biota health
		P181-V1-r: Species diversity
		P182-V1-s: Natural landscape
		P183-V1-t: Effect on current use of land & resources
		P184-V1-u: Effect on rare & endangered species
		P185-V1-v: Effect on human health
		P186-V1-w: Scope for future use of resources
		P187-V1-x: Identifying unforeseen effects
	Awareness Programme	P188-V2-a: Crop/plant selection for minimum pesticides
		P189-V2-b: Appropriate pesticide/ herbicide use
		P190-V2-c: Use of drip irrigation
		P191-V2-d: Recycle/reuse of irrigation water
		P192-V2-e: Appropriate manuring
		P193-V2-f: Anti-litter ordinance
		P194-V2-g: Farmers awareness about climate change
Domain8: DEVELOPMENT AND MANAGEMENT	Goal Conformity	P195-D1-a: National perspective conforming
		P196-D1-b: Regional perspective conforming
		P197-D1-c: Local perspective conforming
		P198-D1-d: Participatory Evaluation
	Role Articulation	P199-D2-a: Roles of project managers- Service continuity
		P200-D2-b: Anticipation of future problems
		P201-D2-c: Roles of project managers- Skills
		P202-D2-d: Roles of project managers- Service performance
		P203-D2-e: Roles of stakeholders
		P204-D2-f: Training of stakeholders- CBO
		P205-D2-g: Training of stakeholders- farmers
		P206-D2-h: Exposure visit of stakeholders- CBO
		P207-D2-i: Exposure visit of stakeholders- farmers
	Dynamic Assessment	P208-D3-a: Level of regulations/ authority sharing
		P209-D3-b: Scope of review/ redirection
		P210-D3-c: Provision of Sustainability audit
		P211-D3-d: Interactions with stakeholders
		P212-D3-e: Fairness and equity in service delivery
		P213-D3-f: Number of Sustained watershed organisations
		P214-D3-g: Number of micro-enterprises
	Statute/Law	P215-D4-a: Conflict management

		P216-D4-b: Nuisance Reduction- Private
		P217-D4-c: Nuisance Reduction- Public
		P218-D4-d: Regulating Water Rights/ Riparian Rights
		P219-D4-e: Regulating Strict Liability
		P220-D4-f: Regulating Trespass
		P221-D4-g: Regulating Negligence
	Monitoring	P222-D5-a: Compliance with legal obligations
		P223-D5-b: Effectiveness of mitigation measures
		P224-D5-c: New Unusual effects
		P225-D5-d: High-valued sites
		P226-D5-e: Repetitive monitoring
		P227-D5-f: Third-party audit

Appendix A3.2: Format of letters to experts/stakeholders for indicator validation

Indian Institute of Technology Guwahati
Centre for Rural Technology
North Guwahati, Assam-781039

Dear Sir/Madam,

I am Mr. Bhabesh Mahanta currently working as a research scholar in the Centre for Rural Technology at Indian Institute of Technology Guwahati under the guidance of Prof. Arup Kumar Sarma and Prof. Sashindra Kumar Kakoty. For my research project, I am studying various performance indicators of watershed management and different factors related to community participation linked to adaptive watershed project management in Assam.
Since you have been involved and associated with the development and implementation of watershed management projects, I invite you to participate in this research study by completing the validity assessment of the selected indicators. Your responses will provide validity of the factors, facilitating the research work.

The following list of indicators attached below will require approximately 20 minutes to complete. A few guidelines are enclosed to assist you in the process.

We assure you that information shared with us will be treated as highly confidential, and its use is intended for academic purposes only.
Thank you for taking the time to assist me in my educational study.

Yours sincerely,

Bhabesh Mahanta
Mobile No: +91 9435301188,

Email: bhabesh@iitg.ac.in

Countersigned By

Prof. Arup Kumar Sarma
Tel: +91 361 258 2433; Email: aks@iitg.ac.in

Prof. Sashindra Kumar Kakoty

Tel: +91 361 2582659; Email: sashin@iitg.ac.in

Guidelines - Part –A

Part A includes the various indicators to assess the performance of an idealised watershed project. You are requested to review the list and judge the indicators' relevance in assessing watershed project performance before filling out the questionnaire.

After validation from your end, some structured questions will be asked of the watershed stakeholders for their opinions on a five-point rating scale, as shown below.

Largely Controlled/Maintained/built	Controlled/Maintained/built	Remains same	Uncontrolled/Unmaintained/built	Largely Uncontrolled/Unmaintained/built
5	4	3	2	1

1 represents "Largely uncontrolled/ Un-maintained"
2 represents "Uncontrolled/Un-maintained/"
3 represents "Remains same."
4 represents "Controlled/Maintained"

5 represents "Largely Controlled/Maintained"

Guidelines - Part –B

Part B includes selected factors for assessing community participation in a watershed project.

Broadly, they are divided into three constructs, namely,

i) COMMUNITY PARTICIPATION IN PLANNING ACTIONS

ii) COMMUNITY PARTICIPATION IN ORGANISATIONAL MANAGEMENT

iii) COMMUNITY PARTICIPATION IN PROJECT PERFORMANCE

For recording the opinions of the stakeholders, we will use a five-point Likert scale as specified below:

Strongly Agree	Somewhat Agree	Don't Know	Somewhat Disagree	Strongly Disagree
5	4	3	2	1

The stakeholders will include Experts in watershed management, the Watershed Technical team, Different community-based organisations, and Village volunteers.

Guidelines - Part –C

It contains an assessment format for the experts/ stakeholders.

Guidelines - Part –D

It contains the personal details of the experts/ stakeholders.

Part C: Assessment form for the use of the expert.

(*Please provide your opinion in the following format. You can add more than one sheet)*)

For	Variables of watershed which are redundant from an ideological point of view in any watershed	Variables of the watershed which are redundant for the specific watershed you worked in.	Probable modification or suggestion of new variables

Part A: Planning Variables			
Part B: Organisational Variables			
Part C: Performance Variables			

Part D: Personal Details of Experts/ Stakeholders

(*Please furnish some personal details about you*)

1. Your Name…………………………………………..

2. Phone No & mail id: ……………………………………

3. Address:

4. Educational Qualification: 1. Graduate: Agricultural/ Engineering/ Forestry/ Water Resource

2. Post-graduate specialisation:

3. Doctoral degree:

5. Your work details:

a) Designation:

b) Experience:

c) Expertise:

d) Publications:

6. Do you have any ideas/suggestions for improving the watershed management scenario?

7. Would you like to help us in the future with any further study in this field?

Signature Date: Place:

Appendix A3.3: WPDI questionnaire sample

Respected Participant,
In a watershed study from IIT Guwahati, we conduct an opinion survey using the questionnaire below. Here, we are selecting some idealistic watershed operational areas. Do you agree that these developments or maintenance are relevant or desirable to your IWMP project?
You are requested to mark your choice in the table below.

Sl No	Domains	Sub-domains	Operational Areas/ Variables	Strongly Agree	Somewhat Agree	No Choice	Somewhat Disagree	Strongly Disagree
1	LAND USE/ MORPHOLOGY	Open Space Management	P1-L1-a: Open Space- Non-agricultural					
			P2-L1-b: Open Space- Agricultural					
			P3-L1-c: Open Space- Agricultural Cropland					
			P4-L1-d: Open Space- Agricultural Rangeland					
			P5-L1-e: Open Space- Parkland					
			P6-L1-f: Open Space- Forested					
			P7-L1-g: Open Space- Undeveloped/ Idle land					
		Plotted Land Management	P8-L2-a: Residential land					
			P9-L2-b: Commercial land					

Appendix A3.4: Results on Sub-domains of Kaldia IWMP

Domains	Sub-domains with code	SD means Gr1	SD means Gr2	MRI	Desirability by threshold MR	Rhos	Congruency by threshold rho	Overall SD Rho	Rho*MRI	Significant Rho*MRI
1. Land use and Morphology	L1 Open Space Management	4.520	2.762	0.095	Desirable	0.45	Congruent	0.010	0.043	0.043
	L3 Physical Land-Water Interactions and Prevention of Extreme Situations	4.927	2.589	0.095	Desirable	0.447	Congruent		0.043	0.043
2. Water and Uses	W1 Water Quantity	4.933	2.779	0.333	Desirable	0.32	Congruent		0.107	0.107
	W2 Water Supply	4.700	2.667	0.074	Desirable	-0.87	Non-congruent		-0.064	
	W3 Flood Management	5.000	2.521	0.125	Desirable	0	Non-congruent		0.000	
3. Production and Economic Activities	P1 Crop Production	4.933	2.880	0.286	Desirable	0.47	Congruent		0.134	0.134
	P2 Economic Audit	5	2.656	0.154	Desirable	0.16	Non-congruent		0.025	
	P3 Livestock	4.880	2.442	0.074	Desirable	0.11	Non-congruent		0.008	
	P4 Population Migration	3.667	2.507	0.054	Undesirable	-1	Non-congruent		-0.054	

	P5 Critical Planning (or budgeting) for Production Areas	4.778	2.654	0.074	Desirable	0.11	Non-congruent		0.008	
4. Forest and natural landscapes	F1 Status Assessment	4.708	2.731	0.091	Desirable	0.44	Congruent		0.040	0.040
6. Socio-cultural Actions	S1 Impact on Education	4.067	2.361	0.050	Undesirable	1	Congruent		0.050	
	S2 Status of Community Actions	4.906	2.451	0.080	Desirable	0.26	Non-congruent		0.021	
	S3 Community Engagement Assessment	4.756	2.668	0.083	Desirable	-0.61	Non-congruent		-0.051	
7. Environmental Activities	V1 Impact Assessment	4.875	2.746	0.133	Desirable	-0.37	Non-congruent		-0.049	
	V2 Awareness Programme	5.000	2.688	0.250	Desirable	0	Non-congruent		0.000	
8. Development and Management	D1 Goal Conformity	4.850	2.332	0.063	Desirable	-0.87	Non-congruent		-0.054	
	D2 Role Articulation	4.933	2.440	0.087	Desirable	-0.37	Non-congruent		-0.032	
	D3 Dynamic Assessment	4.829	2.659	0.083	Desirable	0.18	Non-congruent		0.015	
	D4 Common Law Causes of Action	4.343	2.750	0.087	Desirable	-0.11	Non-congruent		-0.010	

	D5 Monitoring	4.833	2.669	0.100	Desirable	0.26	Non-congruent		0.026	
Total sub-domains	21									
Total desirable sub-domains by TMR	19									
Total sub-domains with nonaligned opinions (with -Ve rho)	9									
Total congruent sub-domains by threshold rhos	6									
Total sub-domains in HR-HM quadrant	5									
Σ (Rho*MRI)	0.366									
WPDI	1.832									
Validity Index	90.48%									
CIP_{SD}	0.01%									

Appendix A3.5: Results on Domains of Kaldia IWMP

Domains	Gr2 Mean	Gr2 Rank	Gr1 Mean	Gr1 Rank3	Mean Rank	Rho	CIPD
Domain7: Environmental Activities	2.717	2	4.938	1	1.5	0.429	18.37%
Domain2: Water and uses	2.656	4	4.878	2	3		
Domain4: Forest and natural landscapes	2.731	1	4.708	5	3		
Domain1: Land use and Morphology	2.676	3	4.724	4	3.5		
Domain8: Development and Management	2.570	6	4.758	3	4.5		
Domain3: Production and Economic Activities	2.628	5	4.652	6	5.5		
Domain6: Socio-cultural Actions	2.494	7	4.576	7	7		

Appendix A3.6: Results on Sub-domains of Turkunijan IWMP

Domains	Sub-domains with code	SD means Gr1	SD means Gr2	MRI	Desirability by threshold MR	Rhos	Congruency by threshold rho	Overall SD Rho	Rho*MRI	Significant Rho*MRI
1. Land use and Morphology	L1 Open Space Management	4.520	2.545	0.080	Desirable	0.783	Congruent	0.136	0.063	0.063
	L3 Physical Land-Water Interactions and Prevention of Extreme Situations	4.927	2.474	0.125	Desirable	0.239	Non-congruent		0.030	0.043
2. Water and Uses	W1 Water Quantity	4.933	2.602	0.333	Desirable	0.210	Non-congruent		0.070	0.107

	W2 Water Supply	4.700	2.573	0.091	Desirable	0.000	Non-congruent		0.000	
	W3 Flood Management	5.000	2.466	0.182	Desirable	0.000	Non-congruent		0.000	
3. Production and Economic Activities	P1 Crop Production	4.933	2.397	0.095	Desirable	0.190	Non-congruent		0.018	
	P2 Economic Audit	5.000	2.576	0.400	Desirable	0.411	Congruent		0.164	0.164
	P3 Livestock	4.880	2.546	0.133	Desirable	0.447	Congruent		0.060	0.060
	P4 Population Migration	3.667	2.658	0.091	Desirable	1.000	Congruent		0.091	0.091
	P5 Critical Planning (or budgeting) for Production Areas	4.778	2.517	0.091	Desirable	0.447	Congruent		0.041	0.041
4. Forest and natural landscapes	F1 Status Assessment	4.708	2.463	0.074	Desirable	0.329	Congruent		0.024	0.024
6. Socio-cultural Actions	S1 Impact on Education	4.067	2.310	0.053	Undesirable	1.000	Congruent		0.053	
	S2 Status of Community Actions	4.906	2.289	0.074	Desirable	-0.293	Non-congruent		-0.022	
	S3 Community Engagement Assessment	4.756	2.361	0.065	Desirable	-0.408	Non-congruent		-0.026	
7. Environmental Activities	V1 Impact Assessment	4.875	2.459	0.087	Desirable	-0.374	Non-congruent		-0.033	
	V2 Awareness Programme	5.000	2.594	0.500	Desirable	0.000	Non-congruent		0.000	

8. Development and Management	D1 Goal Conformity	4.850	2.449	0.080	Desirable	-0.866	Non-congruent		-0.069	
	D2 Role Articulation	4.933	2.225	0.080	Desirable	0548	Congruent		0.044	0.044
	D3 Dynamic Assessment	4.829	2.345	0.067	Desirable	-0.181	Non-congruent		-0.012	
	D4 Common Law Causes of Action	4.343	2.265	0.051	Undesirable	0.738	Congruent		0.038	
	D5 Monitoring	4.833	2.461	0.083	Desirable	0.258	Non-congruent		0.022	
Total sub-domains	21									
Total desirable sub-domains by TMR	19									
Total sub-domains with nonaligned opinions (with -Ve rho)	8									
Total congruent sub-domains by threshold rhos	9									
Total sub-domains in HR-HM quadrant	7									
Σ (Rho*MRI)	0.486									
WPDI	3.405									
Validity Index	90.48%									
CIP_{SD}	1.85%									

Appendix A3.7: Results on Domains of Turkunijan IWMP

Domains	Gr2 Mean	Gr2 Rank	Gr1 Mean	Gr1 Rank	Mean Rank	Rho	CIPD
Domain2: Water Quality & Quantity	2.547	1	4.878	2	1.5	0.178	3.17%
Domain7: Environmental Actions	2.527	3	4.938	1	2		
Domain1: Land Use/ Morphology	2.509	4	4.724	4	4		
Domain3: Production and Economic Activities	2.539	2	4.652	6	4		
Domain8: Development & Management	2.349	6	4.758	3	4.5		
Domain4: Forest & Natural Landscapes	2.463	5	4.708	5	5		
Domain6: Socio-Cultural Actions	2.320	7	4.576	7	7		

Appendix A4.1: CPEF survey questionnaire sample

Sir/Madam,

In research under the Indian Institute of Technology, Guwahati, we consider enhancing Community Participation in watershed programmes. We have identified some relevant actions/variables. Do you think that the following actions/variables will indicate the degree/level of community participation? Please give your opinion below.

Domains under the constructs	Variables/ actions	Agree	Disagree
OA1- Villages/ Local governments like Gram Sabha operation	Q1-OA1-a: Numbers of villages covered		
	Q2-OA1-b: Villagers' activeness and willingness to continue		
OA2- Water Users' Group Operation	Q3-OA2-a: Proper mode of user group selection.		
	Q4-OA2-b: Merit-based selection.		
	Q5-OA2-c: Provision of organisational training.		
	Q6-OA2-d: Users' activeness and willingness to continue.		

Appendix A4.2: CPEF survey respondents' details

A structured questionnaire protocol is designed based on the variables. A questionnaire survey and expert interviews were conducted to glean information and perceptions of the critical project stakeholders relating to these variables. The respondents are classified into two groups using a stratified sampling approach, as shown in the table below.

Group	Interviewee	Organisation	Numbers	Watershed Experience
1	Academic Watershed Experts	Engineering College	2	Ten years
	Water Resource Officers	Government Department	7	20 years
	Watershed Experts	Monitoring Organization	2	Ten years
2	Watershed Managers	IWMP Project	4	Ten years
	Locals	IWMP Project	15	30 years

The questionnaire was directly distributed to the individuals. They are asked to record their agreement using a 2-point scale. In the survey package, a brief introduction about the concept of watershed management and the research objectives are incorporated so that the respondents can appreciate the purpose of the study.

Appendix A4.3: CPEF Survey respondents (2 groups) correlation result

Pearson by Excel	Spearman by Excel	Spearman by Real St	
0.7882	0.8377	Correlation Coefficients	
		Pearson	0.78820548
		Spearman	0.88101521
		Spearman's coefficient (test)	
		Alpha	0.05
		Tails	2
		rho	0.88101521
		t-stat	14.7812714
		p-value	0

Appendix A4.4: Kripendorff's Alpha analysis (CPEF)

Krippendorff's Alpha Gr1			Krippendorff's Alpha Gr2	
Alpha	0.05		Alpha	0.05
Subj Factor	0		Subj Factor	0
Rater Factor	0		Rater Factor	0
kalpha	0.56904425		kalpha	0.92683662
s.e. subj	0.08828559		s.e. subj	0.03354692
lower	0.39267351		lower	0.85981893
upper	0.74541498		upper	0.9938543
s.e. tot	0.12608268		s.e. tot	0.03619406
lower	0.31716513		lower	0.85453067
upper	0.82092336		upper	0.99914257

Appendix A4.5: Inter-group agreement and CPEF Chronbach's Alpha analysis

Summary agreement Table				
		Both	Gr1	Gr2
Total Full Agreement: Both Gr		52	55	52
Total Not in Agreement: Both Gr		13	10	13
Total Percentage of Agreement		80	84.6153846	80
Total Percentage of Non-Agreement		20	15.3846154	20
Cronbach's Alpha Gr1		Cronbach's Alpha Gr2		
0.94019693		0.995909		

Appendix A4.6: T test for CPEF

T Test: One Sample on COV Gr1								T Test: One Sample on COV Gr2							
SUMMARY			Alpha	0.05				SUMMARY		Alpha	0.05				
Count	Mean	Std Dev	Std Err	t	df	Cohen d	Effect r	Count	Mean	Std Dev	Std Err	t	df	Cohen d	Effect r
65	0.04448413	0.11505525	0.01427085	3.11713276	64	0.38663273	0.3630554	65	0.0214	0.07774449	0.00964302	2.21880625	64	0.27520904	0.26726185
T-TEST			Hyp Mean	0				T-TEST			Hyp Mean	0			
	p-value	t-crit	lower	upper	sig				p-value	t-crit	lower	upper	sig		
One Tail	0.00136741	1.66901303			yes			One Tail	0.015	1.66901303			yes		
Two Tail	0.00273483	1.99772965	0.01597483	0.07299342	yes			Two Tail	0.0301	1.99772965	0.00213185	0.04066013	yes		
T Test: Two Independent Samples															
SUMMARY			Hyp Mean Diff	0											
Groups	Count	Mean	Variance	Cohen d											
Group 1	65	1.91888112	0.04600286												
Group 2	65	1.82510121	0.13643592												
Pooled			0.09121939	0.31050329											

T TEST: Equal Variances			Alpha	0.05					
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	0.05297877	1.77014111	128	0.03954222	1.65684523			yes	0.1546
Two Tail	0.05297877	1.77014111	128	0.07908445	1.97867085	-0.01104765	0.19860746	no	0.1546
T TEST: Unequal Variances			Alpha	0.05					
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	0.05297877	1.77014111	102.752775	0.03983482	1.65981852			yes	0.172
Two Tail	0.05297877	1.77014111	102.752775	0.07966964	1.98332086	-0.011294	0.19885381	no	0.172

Appendix A4.7: List of 52 final CPEF variables

	VARIABLES
1	Q1-OA1-a: Numbers of villages covered
2	Q2-OA1-b: Villagers' activeness and willingness to continue
3	Q3-OA2-a: Proper mode of user group selection.
4	Q5-OA2-c: Provision of organisational training.
5	Q6-OA2-d: Users' activeness and willingness to continue.
6	Q9-OA3-c: Provision of organisational training.
7	Q10-OA3-d: Willingness to continue.
8	Q12-OA4-b: Attentiveness of the watershed technical team to local problems.
9	Q13-OA4-c: Promptness of the watershed technical team to service.
10	Q15-OA4-e: Coordination of the watershed technical team in auditing.
11	Q16-OA4-f: Coordination of the watershed technical team in project actions.
12	Q17-OA5-a: Active association by SHGs.
13	Q18-OA5-b: Periodic training about their roles.
14	Q19-OA5-c: Willingness for inter-group cooperation.
15	Q20-OA5-d: Willingness for helping problem mitigation.
16	Q21-CMA1-a: Well-defined mode of transfer/ role allocation/authority sharing from providers and participants.
17	Q23-CMA2-a: The project is technically manageable by the users.
18	Q24-CMA2-b: Provision of differential service and supply facility for the users.
19	Q27-CMA2-e: Scheduling and timeliness.
20	Q28-CMA2-f: Scope of innovation and adaptability.
21	Q29-CMA3-a: Legality and flexibility of pricing
22	Q30-CMA3-b: Compatibility of rules and norms with the statute and common law practices.
23	Q31-CMA3-c: Scope of dispute management.
24	Q32-CMA3-d: Provision of distinct authority sharing.
25	Q33-CMA3-e: Secured land tenure policy.
26	Q34-CMA3-f: Government support in rules and legality.
27	Q35-CMA3-g: Resilience to political sensitivity.
28	Q36-CMA4-a: Awareness of the community about financing mode/investment opportunities
29	Q37-CMA4-b: Awareness of the community about the profitability of the project.
30	Q38-CMA4-c: Community adopting the accounting/auditing practices
31	Q39-CMA4-d: Awareness of the community about the project B/C ratio
32	Q40-CMA4-e: Faith of the community about the stability of financial policies
33	Q41-CMA4-f: The financial appeal of the project to the community.
34	Q43-CMA5-a: Existence of feasibility study before project planning.
35	Q45-CMA5-c: Effectiveness of the project for meeting long-term demand.
36	Q46-CMA5-d: Scope of extension service delivery.
37	Q48-CMA5-f: Scope for financial auditing.
38	Q49-CMA5-g: Project inducing stability to the economic environment.
39	Q50-CMA6-a: Value addition to the socio-cultural cohesion.
40	Q51-CMA6-b: Equitable service delivery
41	Q52-CMA6-c: Inducing job opportunities.

42	Q53-CMA6-d: Effective rehabilitation/ compensation policies
43	Q55-CMA6-f: Acceptable tariffs/ levies.
44	Q56-CMA6-g: Encouraging constructive migration of people
45	Q57-CMA7-a: Initiating environmental sustainability.
46	Q58-CMA7-b: Inducing soil degradation prevention
47	Q59-CMA7-c: Emphasise for pollution prevention.
48	Q60-CMA8-a: Arranging developmental training and workshops for stakeholders.
49	Q61-CMA8-b: Demonstrating evidence of enhanced capability/ resource utilisation.
50	Q62-CMA8-c: Encouraging Case study/ analysis/ qualitative feedback amongst stakeholders.
51	Q63-CMA8-d: Effort for controlling staff/ stakeholders' performance/ engagements.
52	Q64-CMA8-e: Scoping knowledge/ best practices management.

Appendix A4.8: CPI data analysis for Turkunijan IWMP (sample page)

	Community Participation Data				Turkuni															
			Scores										3	2	1					
	Oas	Questions	3	2	1	0	Questionwise Total	Actionwise Total	Respondents	Actionwise Max Score	Actionwise pc score	Total Respondents	Ratio of 3 scorers	Ratio of 2 scorers	Ratio of 1 scorers	Questionwise Score	Sub domain wise total	Sub domain wise Max	Sub domain wise percentage score	All sub domains average score
1	OA1	1	2	25	30	3	86	205	57	171	62.12121	60	0.033333	0.416667	0.5	1.433333333	3.521052632	6	58.68	43.34
		2	24	18	11	4	119		53	159	0	57	0.421053	0.315789	0.192982456	2.087719298				
2	OA2	3	17	20	9	7	100	175	46	138	67.04981	53	0.320755	0.377358	0.169811321	1.886792453	3.241704619	9	36.02	
		5	3	11	7	32	38		21	63	0	53	0.056604	0.207547	0.132075472	0.716981132				
		6	3	11	6	38	37		20	60	0	58	0.051724	0.189655	0.103448276	0.637931034				
3	OA3	9	6	13	10	24	54	164	29	87	68.33333	53	0.113208	0.245283	0.188679245	1.018867925	3.018867925	6	50.31	
		10	23	13	15	4	110		51	153	0	55	0.418182	0.236364	0.272727273	2				
4	OA4	12	11	17	16	13	83	295	44	132	62.6327	57	0.192982	0.298246	0.280701754	1.456140351	5.240088859	12	43.67	
		13	10	15	14	17	74		39	117	0	56	0.178571	0.267857	0.25	1.321428571				
		15	9	14	10	22	65		33	99	0	55	0.163636	0.254545	0.181818182	1.181818182				
		16	9	14	18	16	73		41	123	0	57	0.157895	0.245614	0.315789474	1.280701754				
5	OA5	17	6	23	12	10	76	255	41	123	59.85915	51	0.117647	0.45098	0.235294118	1.490196078	4.68164907	12	39.01	
		18	4	11	6	31	40		21	63	0	52	0.076923	0.211538	0.115384615	0.769230769				
		19	5	24	19	12	82		48	144	0	60	0.083333	0.4	0.316666667	1.366666667				
		20	7	11	14	22	57		32	96	0	54	0.12963	0.203704	0.259259259	1.055555556				
6	CMA1	21	2	14	7	16	41	41	23	69	59.42029	39	0.051282	0.358974	0.179487179	1.051282051	1.051282051	3	35.04	
7	CMA2	23	8	24	11	6	83	303	43	129	61.58537	49	0.163265	0.489796	0.224489796	1.693877551	6.214285714	12	51.79	
		24	9	19	12	9	77		40	120	0	49	0.183673	0.387755	0.244897959	1.571428571				
		27	9	15	15	9	72		39	117	0	48	0.1875	0.3125	0.3125	1.5				
		28	9	11	22	7	71		42	126	0	49	0.183673	0.22449	0.448979592	1.448979592				

Appendix A5.1: Sample Inter-rater Reliability (Kalpha) testing list regarding categories of goals in a watershed project

By 5 Raters for 8 Ratings (A to H)		Goals in Assamese	Rating Table					Agreement Table							
Goal No	Goals	আঁচনিমতে প্ৰাপ্ত লক্ষ্যসমূহ	Person 1	Person 2	Person 3	Person 4	Person 5	A	B	C	D	E	F	G	H
1	1 a The vegetative cover of the project area is increased.	অঞ্চলটোৰ উদ্ভিদজ আৱৰণ বাঢ়িছে৷	A	A	A	A	A	5	0	0	0	0	0	0	0
2	2 a The degraded ecosystem is restored by the project.	আঁচনিখনে পৰিস্থিতিতন্ত্ৰৰ অৱক্ষয় নিয়ন্ত্ৰণ কৰিছে৷	A	A	A	C	A	4	0	1	0	0	0	0	0
3	3 a Rain water conservation/soil moisture retention is encouraged.	আঁচনিখনে বৰষুণৰ পানীৰ সংৰক্ষণ আৰু জলীয় বাষ্প ৰক্ষণ উৎসাহিত কৰিছে৷	D	D	D	D	D	0	0	0	5	0	0	0	0
4	3 b Velocity of runoff water has decreased.	আঁচনিখনে উকলি যোৱা পানীৰ বেগ কমাইছে৷	C	C	D	C	C	0	0	4	1	0	0	0	0
5	3 c Ground water recharge is encouraged through surface water storage, dug out ponds, ring wells	পৃষ্ঠভূমিত খন্দা পানী জমা ৰখা খাল, কুঁৱা আদিৰে ভূত্বকৰ পানী সম্পূৰণ কৰা হৈছে৷	D	D	D	D	D	0	0	0	5	0	0	0	0
6	3 d The project provides alternatives for rejuvenation of water bodies/water budgeting.	আঁচনিখনে জলাশয়ৰ পানী পৰিপূৰণ কৰাৰ আৰু জল বাজেটৰ দিহা ৰাখিছে৷	D	D	D	D	D	0	0	0	5	0	0	0	0
7	3 e Shallow tube wells (54 proposed), ponds and hand pumps (proposed 22) are constructed to meet drinking water need.	পেয় পানীৰ জোৰা মাৰিবলৈ অগভীৰ নলীনাদ(প্ৰস্তাৱমতে ৫৪টা), পুখুৰী আৰু দমকল(প্ৰস্তাৱমতে ২২টা), সজা হৈছে৷	D	D	D	D	D	0	0	0	5	0	0	0	0
8	4 a The Users Groups are being trained (Proposed 96 families).	উপভোক্তা গোটবোৰক (প্ৰস্তাৱিত ৯৬ টা) প্ৰশিক্ষণ দিয়া হৈছে৷	B	B	G	B	B	0	4	0	0	0	0	1	0
9	4 b The Self-Help Groups are being trained (Proposed to promote 150).	আত্ম-সহায়ক গোটবোৰক (প্ৰস্তাৱিত ১৫০ টা) প্ৰশিক্ষণ দিয়া হৈছে৷	G	G	G	G	G	0	0	0	0	0	0	5	0
10	4 c The Watershed Committees (17 numbers comprising of 10 members each) are formed by Gram Sabha and are being trained.	জলচ্ছেদ সমিতিৰ(১৭ খন, প্ৰতিখন ১০ জনীয়া) গোটবোৰ গাওঁসভাই গঠন কৰিছে আৰু তেওঁলোকক প্ৰশিক্ষণ দিয়া হৈছে৷	G	G	G	G	G	0	0	0	0	0	0	5	0
11	4 d The project undertook participatory rural appraisal exercises like participatory modelling, transact walk, seasonality technique, matrix ranking, time line etc.	আঁচনিখনত অংশীদাৰী গ্ৰাম্য মূল্যায়নৰ বিভিন্ন পন্থাৰ সুবিধাসমূহ ৰখা হৈছে৷	G	H	G	G	G	0	0	0	0	0	0	4	1

12	5 a There is coordination between project implementing agency (PIA) and beneficiaries.	আঁচনি ৰূপায়ক সংস্থা আৰু উপভোক্তাৰ মাজত সংঘবদ্ধতা আছে।	G	G	G	G	G	0	0	0	0	0	0	5	0
13	5 b The Producers' Collective group is formed and they are attentive to the project activities.	উৎপাদনকাৰীৰ সামূহিক দল গঠন কৰা হৈছে আৰু তেওঁলোক আঁচনিৰ প্ৰতি মনোযোগী।	G	G	G	B	G	0	1	0	0	0	0	4	0
14	5 c There is good collaboration of watershed managers with village community.	গ্ৰাম্য জনসংহতি আৰু জলচ্ছেদ পৰিচালকৰ মাজত ভাল বুজাবুজি আছে।	G	G	G	G	G	0	0	0	0	0	0	5	0
15	5 d There is good collaboration of watershed managers with gram panchayatas (GP)/ DRDA/ ZP cells..	গাঁও পঞ্চায়ত/ গাওঁ উন্নয়ন কৰ্তৃপক্ষ/ জিলা পৰিষদ আৰু জলচ্ছেদ পৰিচালকৰ মাজত ভাল বুজাবুজি আছে।	G	G	G	G	G	0	0	0	0	0	0	5	0
16	5 e The watershed committee (WC) is active and alert.	জলচ্ছেদ সমিতি সক্ৰিয় আৰু সচেতন বুলি ধাৰণা হয়।	G	G	G	G	G	0	0	0	0	0	0	5	0
17	5 f The SHGs are formed by watershed committee with due diligence- including female members.	আত্ম-সহায়ক গোটবোৰ (জলচ্ছেদ কমিটিয়ে) গঠন কৰোঁতে যথানিয়মে মহিলা সদস্য অন্তৰ্ভূক্ত হৈছে।	G	G	G	G	G	0	0	0	0	0	0	5	0
18	5 g The SHGs are formed with due diligence- including SC/ST members.	আত্ম-সহায়ক গোটবোৰ গঠন কৰোঁতে যথানিয়মে অনুসূচীত জাতি-জনজাতি সদস্য অন্তৰ্ভূক্ত হৈছে।	G	G	G	G	G	0	0	0	0	0	0	5	0
19	5 h The SHGs are formed with due diligence- including BPL members.	আত্ম-সহায়ক গোটবোৰ গঠন কৰোঁতে যথানিয়মে দৰিদ্ৰতা সীমাৰ তলৰ সদস্য অন্তৰ্ভূক্ত হৈছে।	B	B	B	B	B	0	5	0	0	0	0	0	0
20	5 i The UGs are formed by watershed committee with due diligence- including female members.	উপভোক্তা গোটবোৰ (জলচ্ছেদ কমিটিয়ে)গঠন কৰোঁতে যথানিয়মে মহিলা সদস্য অন্তৰ্ভূক্ত হৈছে।	B	G	B	B	B	0	4	0	0	0	0	1	0
21	5 j The UGs are formed with due diligence- including SC/ST members.	উপভোক্তা গোটবোৰ গঠন কৰোঁতে যথানিয়মে অনুসূচীত জাতি-জনজাতি সদস্য অন্তৰ্ভূক্ত হৈছে।	B	G	B	B	B	0	4	0	0	0	0	1	0
22	5 k The UGs are formed with due diligence- including BPL members.	উপভোক্তা গোটবোৰ গঠন কৰোঁতে যথানিয়মে দৰিদ্ৰতা সীমাৰ তলৰ সদস্য অন্তৰ্ভূক্ত হৈছে।	B	B	B	B	B	0	5	0	0	0	0	0	0

Appendix A5.2: Kripendorff's Alpha analysis (PI)

Krippendorff's Alpha	
Alpha	0.05
Subj Factor	0
kalpha	0.777753
s.e.	0.030506
lower	0.71681
upper	0.838696

Appendix A5.3: Goal-wise performance score of all IWMP

Table A5.3a: Goal-wise performance score for Kaldia IWMP

Watershed Goals	Percentage Scores
A. Naturalisation and Afforestation	0.241
1 a. The vegetative cover of the project area is increased.	0.065
2 a. The project restores the degraded ecosystem.	0.115
7 a. As proposed, an additional forest coverage of 37 ha in Naljhara is realised.	0.060
B. Socio-Economic Upgradation	1.427
13 g. One hundred eighty-three nos of SHG and farmers group has undertaken micro enterprises like handloom, pottery making, carpentry, mobile repairing, vermin compost, bamboo craft, tarja making etc.	0.247
13 h. As planned, 70 nos of UCs are formed.	0.059
14 a. The project helped to improve human development.	0.209
14 d. The project improves combined economic outcomes.	0.224
14 f. The project helped to control distress migration.	0.028
4 a. The user groups are being trained.	0.033
5 h. The SHGs are formed with due diligence- including BPL members.	0.430
5 k. The UGs are formed with due diligence- including BPL members.	0.059
5 m. The UGs are active and alert.	0.071
6 a. Rice production is raised through quality seeds and high-yielding varieties.	0.067
C. Soil and Land Management	1.321
11 a. The project has checked soil erosion/siltation.	0.069
11 b. As proposed, four nos of RCC check dams, drop spillways, farm ponds, and earthen embankments are completed.	0.247
11c. As proposed, six water distribution canals are constructed in the project area.	0.242
12 a. To arrest the runoff water, 15 earthen dams (involving 28360 RM) are constructed.	0.227
12 c. As proposed, the dams protect the paddy fields from inundation by the Naljhara River floodwater.	0.054
3 b. The velocity of runoff water has decreased.	0.233
7 c. Plantation on the roadside, river bank, and institutional campus is done.	0.248
D. Water Resource Management	0.637
13 a. Hand pumps and tube wells for drinking water are realised.	0.230
3 a. Rainwater conservation is encouraged.	0.101

3 c. Groundwater recharge is encouraged through surface water storage, dug-out ponds, ring wells	0.033
3 d. The project provides alternatives for the rejuvenation of water bodies.	0.052
3 e. Ten deep tube wells are constructed to recharge groundwater and meet drinking water needs.	0.220
E. Agricultural Production	0.433
11 d. Provisions for using water pumps for Kharif crops have been made.	0.048
12 b. As proposed, these will help 500 ha of cultivated field.	0.240
13 b. Central nursery at the Mahavairab Mandir is realised.	0.033
6 b. Production of rice is raised through the creation of irrigation potentials.	0.027
6 c. There are efforts on the agricultural processing of different produce like cereals, oil seeds, fruits, etc.	0.026
6 d. There are efforts on agricultural marketing of different produce like cereals, oil seeds, fruits, etc.	0.013
6 e. There are efforts to implement crop demonstration programmes on different agricultural produce.	0.014
6 f. The proposed one of the central nurseries with three lakh horticultural species is realised.	0.000
7 b. The plantation of bamboo is encouraged.	0.021
8 a. As proposed, a rubber plantation of 108 ha is realised.	0.013
8 b As proposed, the 2 ha area of fodder grass is raised.	0.000
8 c. The output has been sold or distributed to beneficiaries.	0.000
F. Animal Husbandry and Pisciculture	0.665
10 a. The project has developed pisciculture.	0.098
10 b. To facilitate fish rearing, firm ponds and fishery ponds are constructed.	0.067
13 i. Poultry development is done.	0.000
13 j. Piggery development is done.	0.000
13 k. Weaving development is done.	0.000
9 a. The project helped to develop the rearing of livestock and poultry.	0.252
9 b. 133 units of SHG have taken up schemes of rearing cows, poultry, piggery, duckery, beekeeping, etc	0.248
G. Social Capital Development	2.868
14 b. The project helped to improve gender equality.	0.248
14 c. The project helped to improve social cohesion.	0.082
14 e. The project helped to improve the nutritional needs of users.	0.040
4 b. The Self-Help Groups are being trained.	0.229
4 c. The Watershed Committees are being trained.	0.238
4 d. The project undertook participatory rural appraisal exercises.	0.085
5 a. There is coordination between the project implementing agency (PIA) and beneficiaries.	0.184
5 b. The watershed development team (WDT) is attentive to the project activities.	0.173
5 c. The watershed managers collaborate well with the village community.	0.067
5 d. Watershed managers collaborate well with Gram Panchayatas (GP).	0.026
5 e. The watershed committee (WC) is active and alert.	0.237
5 f. The SHGs are formed with due diligence- including female members.	0.397
5 g. The SHGs are formed with due diligence- including SC/ST members.	0.438
5 i. The UGs are formed with due diligence- including female members.	0.059
5 j. The UGs are formed with due diligence- including SC/ST members.	0.080

5 l. The SHGs are active and alert.	0.236
5 n. Collaboration is good with DRDA/ ZP cells.	0.049
H. Associated Infrastructure Development	1.024
13 c. Playground improvement at SKKH School is done.	0.250
13 d. Improvement of the Anganwadi centre at Sariha Chakla is done.	0.261
13 e. Improvement of GP offices at Nityananda Panbari is done.	0.262
13 f. Improvement of Samiti playground at Bamunpara is done.	0.250
Grand Total	8.615

Table A5.3b: **Goal-wise performance score for Satpokholi IWMP**

Watershed Goals	Percentage score
A Naturalisation and Afforestation	0.287
1 a. The vegetative cover of the project area is increased.	0.162
2 a. The project controls the degraded ecosystem.	0.068
7 a. As proposed, additional forest coverage is realised.	0.023
7 b. Plantation is encouraged.	0.034
B. Socio-Economic Upgradation	0.625
13 c. 1000 poor households are covered under SHG.	0.085
13 d. UGs are formed to include 1000 persons.	0.085
13 e. Watershed committees are formed to include 1000 persons	0.078
13 f. Exposure training (on NRM/Enterprise Promotion/ Productivity Enhancement) for 500 persons is held.	0.046
14 a. The project helped to improve human development.	0.068
14 d. The project improves combined economic outcomes.	0.052
14 f. The project helped to control distress migration.	0.032
4 a. The Users Groups (UG) are being trained.	0.057
5 h. The SHGs are formed with due diligence- including BPL members.	0.060
5 k. The UGs are formed with due diligence- including BPL members.	0.028
5 m. The UGs are active and alert.	0.033
C. Soil and Land Management	0.283
11 a. The project has checked erosion/ siltation.	0.032
11 b. As proposed, three nos of RCC check dams are completed.	0.032
11 c. As proposed, 35 water distribution canals are constructed in the project area.	0.027
12 a. To arrest the runoff water, 11 earthen dams are constructed.	0.027
12 c. The project had a vision for open space land and plotted land management.	0.028
3 b. The velocity of runoff water has decreased.	0.050
7 c. Plantation on the roadside, river bank, and institutional campus is done.	0.087
D. Water Resource Management	0.257
11 d. The project contributed to the reduction of waterlogging.	0.029
13 a. 65 numbers of hand pumps were installed as entry point activity.	0.089
3 a. Rainwater conservation/harvesting is encouraged.	0.043
3 d. The project provides alternatives for the rejuvenation of water bodies.	0.023
3 e. Wells are constructed to meet drinking water needs.	0.024
3 c. Groundwater recharge is encouraged through surface water storage, dug-out ponds, and ring wells.	0.049

E. Agricultural Production	0.327
12 b. As proposed, these will help 48 ha of cultivated field.	0.046
6 b. Production of rice is raised through the creation of irrigation potentials.	0.032
6 c. There are efforts in the industrial processing of different produce like cereals, oil seeds, fruits, etc.	0.046
6 d. There are efforts on agricultural marketing of different produce like cereals, oil seeds, fruits, etc.	0.046
6 e. There are efforts to implement low-cost go-downs in the storage of agricultural produce.	0.019
6 f. Provisions for brick canals and water storage for Kharif & rabi crops have been made.	0.027
6 a. Rice production is raised through quality seeds and high-yielding varieties.	0.036
8 b. As proposed, the horticulture, ginger, turmeric and banana plantations are raised.	0.037
8 c. The output has been sold or distributed to beneficiaries.	0.037
F. Animal Husbandry and Pisciculture	0.378
10 a. The project has improved pisciculture.	0.024
10 b. To facilitate fish rearing, firm ponds and fishery 23 ponds are constructed.	0.038
13 b. Fishery developments are done.	0.059
13 g. 102 goatery developments are done.	0.042
13 h. 96 duckery developments are done.	0.028
13 i. 102 poultry development is done.	0.027
13 j. 93 piggery development is done.	0.032
13 k. 93 weaving developments are done.	0.053
9 a. The project helped to develop the rearing of livestock and poultry.	0.032
9 b. 56 units of SHG and 50 units of UGs have taken up schemes of rearing cows, poultry, piggery, duckery, beekeeping, vermin compost, etc.	0.043
G. Social Capital Development	1.040
14 b. The project helped to improve gender equality.	0.052
14 c. The project helped to improve social cohesion.	0.069
14 e. The project helped to improve the nutritional needs of users.	0.050
4 b. The Self-Help Groups (SHG) are being trained.	0.102
4 c. The Women Groups are being trained.	0.141
5 a. There is coordination between the project implementing agency (PIA) and beneficiaries.	0.068
5 b. The Watershed Development Team (WDT) is attentive to the project activities.	0.057
5 c. The watershed managers collaborate well with the village community.	0.051
5 d. Watershed managers collaborate well with Gram Panchayatas (GP).	0.125
5 e. The watershed committee (WC) is active and alert.	0.019
5 f. The SHGs are formed with due diligence- including female members.	0.075
5 g. The SHGs are formed with due diligence- including SC/ST members.	0.075
5 i. The UGs are formed with due diligence- including female members.	0.029
5 j. The UGs are formed with due diligence- including SC/ST members.	0.059
5 l. The SHGs are active and alert.	0.046
5 n. Collaboration is good with DRDA/ ZP cells.	0.023
H Associated Infrastructure Development	0.113
4 d. The project undertook participatory rural appraisal exercises.	0.052
8 a. As proposed, fuel wood plantation is realised.	0.060
Grand Total	3.310

Table A5.3c: Goal-wise performance score for Turkunijan IWMP

Watershed Goals	Percentage score
A. Naturalisation and Afforestation	0.880
1 a. The vegetative cover of the project area is increased.	0.323
13 d. The area under forest/vegetation increases by 13 ha.	0.140
2 a. The project restores the degraded ecosystem.	0.228
7 a. As proposed, an additional forest coverage of 13.96 ha is realised.	0.190
B. Socio-Economic Upgradation	4.058
13 g. One hundred fifty nos of SHG and farmers group has undertaken micro enterprises like handloom, pottery making, carpentry, mobile repairing, vermin compost, bamboo craft, tarja making etc.	0.226
13 h. Works for 30 days for 169 persons (a total of 156845 person-days) is created to reduce labourer migration.	0.292
14 a. The project helped to improve human development.	0.293
14 d. The project improves combined economic outcomes.	0.322
14 f. The project helped to control distress migration.	0.195
4 a. The user groups are being trained (Proposed 96 families).	0.167
5 h. The SHGs are formed with due diligence- including BPL members.	0.387
5 i. The UGs are formed by watershed committees with due diligence- including female members.	0.426
5 j. The UGs are formed with due diligence- including SC/ST members.	0.340
5 k. The UGs are formed with due diligence- including BPL members.	0.400
5 l. The SHGs are active and alert.	0.381
5 m. The UGs (a total of 18 numbers) are active and alert.	0.311
5 n. In total, 18 user groups are formed.	0.318
C. Soil and Land Management	1.802
11 a. The project has checked soil erosion/siltation.	0.319
11 b. As proposed, check dams, drop spillways, farm ponds, and earthen embankments are completed.	0.258
11 c. As proposed, water distribution canals are constructed in the project area.	0.159
12 a. To arrest the runoff water, earthen dams are constructed.	0.292
12 c. As proposed, the dams protect the paddy fields from flood inundation.	0.327
3 b. The velocity of runoff water has decreased.	0.285
7 c. Plantation on the roadside, river bank, and institutional campus is done.	0.162
D. Water Resource Management	1.351
13 a. Hand pumps and tube wells for drinking water are realised.	0.213
3 a. Rainwater conservation/soil moisture retention is encouraged.	0.254
3 c. Groundwater recharge is encouraged through surface water storage, dug-out ponds, and ring wells.	0.261
3 d. The project provides alternatives for the rejuvenation of water bodies/water budgeting.	0.295
3 e. Shallow tube wells (54 proposed), ponds and hand pumps (proposed 22) are constructed to meet drinking water needs.	0.327
E. Agricultural Production	2.437
11 d. Provisions for using water pumps for Kharif crops have been made.	0.225
12 b. As proposed, these will help cultivate the field.	0.285
13 b. Irrigation potential has been raised by 110 ha.	0.144

13 c. The area under double cropping increased by 110 ha.	0.156
13 e. The area under horticulture increases by 8 ha.	0.195
6 a. Rice production is raised through quality seeds and high-yielding varieties.	0.266
6 b. Production of rice is raised through the creation of irrigation potentials.	0.161
6 c. There are efforts on agricultural processing of different produce like cereals, oil seeds, fruits, etc.	0.158
6 d. There are efforts on agricultural marketing of different surplus produce like cereals, oil seeds, fruits/ milk, etc.	0.141
6 e. There are efforts to implement crop demonstration programmes on different agricultural produce.	0.162
7 b. As proposed, the growth of the cropped area (approximately 340 ha) is achieved.	0.160
8 a. As proposed, cash crops like jute are being increased.	0.093
8 b. As the proposed wheat crop is increased.	0.107
8 c. As proposed, crops like pulses and oil seeds are increased.	0.183
F. Animal Husbandry and Pisciculture	1.421
10 a. The project has developed pisciculture.	0.265
10 b. To facilitate fish rearing, firm ponds and fishery ponds are constructed.	0.220
13 f. Milk production increases by two times.	0.195
6 f. As proposed, training on weaving/ fishery (25 weaving units) and dairying (6 dairy units), goatery (26 units), and poultry (123 units) are realised.	0.211
9 a. The project helped to develop livestock and poultry rearing for asset-less/marginal labourers.	0.295
9 b. To help asset-less/marginal labourers, SHGs (total 150-160) have taken up schemes of rearing cows, poultry, piggery, duckery, beekeeping, etc.	0.236
G. Social Capital Development	4.537
14 b. The project helped to improve gender equality.	0.285
14 c. The project helped to improve social cohesion.	0.289
14 e. The project helped to improve the nutritional needs of users.	0.220
4 b. The Self-Help Groups are being trained (Proposed to promote 150).	0.182
4 c. Gram Sabha forms the Watershed Committees (17 numbers comprising ten members each) and is being trained.	0.325
4 d. The project undertook participatory rural appraisal exercises like participatory modelling, transact walk, seasonality technique, matrix ranking, timeline, etc.	0.352
5 a. There is coordination between the project implementing agency (PIA) and beneficiaries.	0.348
5 b. The Producers' Collective group is formed and is attentive to the project activities.	0.363
5 c. The watershed managers collaborate well with the village community.	0.392
5 d. Watershed managers collaborate well with gram panchayatas (GP)/ DRDA/ ZP cells.	0.422
5 e. The watershed committee (WC) is active and alert.	0.482
5 f. The SHGs are formed by the watershed committee with due diligence- including female members.	0.467
5 g. The SHGs are formed with due diligence- including SC/ST members.	0.410
H. Associated Infrastructure Development	0.000
13 i. Children's parks and historic sites are developed.	0.000
13 j. Roads and bridges are built/developed.	0.000
13 k. Public utilities are built/developed.	0.000
Grand Total	16.486

Appendix A6.1 Fieldwork approach

The study objectives specify that the development and pilot application of the metric should be made in three watershed projects (Kaldia IWMP, Satpokholi IWMP and Turkunijan IWMP) in Brahmaputra Valley, Assam (India). The primary selection criteria were similar protocols, hydrological characteristics, socio-economic settings, and operationalisation period (2010-12), and it is situated on the North bank and the south bank of the Brahmaputra River. Finally, the projects were selected based on the cooperative attitudes of the community, which was ascertained by preliminary visits and meetings in the project areas.

The study approach focused on understanding community perceptions of planning, organising, and managing programme outcomes to evaluate the degree of alignment of perceptions about the planned goals of the programme and achieved performance.

The data collection process was a series of structured field surveys to understand the main features of participation and accountability relations in the project areas, focused on (a) watershed outcomes against planned provisions, (b) organisational behaviour, involvement and responsibility. Within the project areas, community members are selected through focused group discussions and workshops on watershed project protocols, objectives and preliminary information sharing with the CBOs and community members. Interviews were conducted with water sector academicians, project experts, monitoring experts, panchayat members, and local community representatives to get their opinions on the questionnaires.

Field data collection took place over six months. The data collection through FGDs and critical information interviews (KIIs) was done using the local language and accompanied by local volunteers who knew the areas well. In each project, two public meetings, eight FGDs and at least seven KIIs were conducted, resulting in six public meetings, 24 FGDs and 21 KIIs. Most of the participants are community members and members of project-level watershed organisations. The following research modes were undertaken to scrutinise the state of participation:

a) Perform a transact walk through the project area, look for the watershed components, and interact with the local people.

b) Organising meetings with the villagers at different public places.

c) Conducting interacting sessions with the IWMP officials, Watershed Development Council members, members of Gram Sabhas and members of Community Based Organisations.

d) Record public opinion and take photographs of critical components in the project areas.

e) KIIs with watershed officials (e.g. watershed project directors, watershed project managers, WDT and WDC functionaries and experts of watershed project monitoring and evaluation agencies), besides group discussions with key informants such as members of the Gram Panchayatas and citizens with local standings.

List of Publications

Journal Papers

1. Mahanta, B., Sarma, A. K., & Kakoty, S. K. (2024). Harmonising Sakeholders' Perspectives: A Watershed Project Desirability Index. *Water Conservation Science and Engineering*, *9*(1). https://doi.org/10.1007/s41101-024-00242-2

2. Mahanta, B., Sarma, A. K., & Kakoty, S. K. (2024). Conceptualising a socially resilient multi-dimensional framework for bottom-up evaluation of community participation mechanism in a watershed management space. *Environment Systems and Decisions*, Springer (Under Review) (communicated). Submission ID 637ce9d7-b7cf-4871-a34c-db8f78b5ad08

3. Mahanta, B., Sarma, A. K., & Kakoty, S. K. (2024). Bridging the gap: Assessing performance and planned importance in watershed projects using participatory methods. *Journal of Institution of Engineers.* (SCOPUS) (Under Review) (communicated), Submission ID: IEIA-D-23-00359R1

4. Mahanta, B., Sarma, A. K., & Kakoty, S. K. (2024). The development of a multi-dimensional integrated watershed index (IWI) aggregating different indices. (Under Preparation).

Book Chapter

Mahanta, B., Sarma, A. K., & Kakoty, S. K. (2023). An indexing method for evaluating the managerial effectiveness of a watershed project and functional involvement of participant organisations. Published as a book chapter in the book:

Ecosystem Restoration: Towards Sustainability and Resilient Development, (Editors: Anil Kumar Gupta · SVRK Prabhakar · Akhilesh Surjan), ISBN: 978-981-99-3687-8, ISSN: 2662-4893, DOI: https://doi.org/10.1007/978-981-99-3687-8, 2023.