Conceptualising a Socially Resilient Multi-Dimensional Framework for Bottom-Up Evaluation of Community Participation Mechanism in a Watershed Management Space

Bhabesh Mahanta (bhabesh@iitg.ac.in)
Indian Institute of Technology Guwahati https://orcid.org/0000-0002-8779-440X
SARMA ARUP KUMAR
Indian Institute of Technology Guwahati
KAKOTY SASHINDRA KUMAR
Indian Institute of Technology Guwahati

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Abstract

In any integrated watershed management programme (IWMP), community participation is indispensable. The success of the community participation mechanism (CPM) correlates positively with IWMP accomplishment. However, unlike watershed success evaluation, CPM, in practice, is seldom evaluated, nor is there a theoretical framework developed to baseline such assessment from stakeholders' perspective. This paper conceptualises a socially resilient community participation evaluation framework (CPEF) for bottom-up evaluation of watershed CPM to bridge this knowledge gap. For identifying various critical domains and variables for CPEF from a socio-hydrological perspective, we studied Integrated Water Resource Management (IWRM) and IWMP programme policies and literature. Based on crucial watershed management actions, we built two constructs for the framework: (1) organisational - consisting of 36 organisational actions (OAs) in 10 domains of organisational management and (2) managerial – consisting of 46 critical management actions (CMAs) in 8 domains of management practices usually carried out in watershed space. This framework was verified in the IWMP areas of Brahmaputra valley in Assam, India. We applied a stratified structured questionnaire survey method to collect opinions of randomly sampled participants from three group of IWMP stakeholders' in four IWMP projects. We employed relevant statistical tests for analysing primary field data to obtain the most appealing set of community actions for the final CPEF. The results present an overview of the current state of CPM and a set of excludable actions. This evaluation framework methodology can be utilised to gauge community participation endeavour and improve cooperation, system redirection, and goal articulation in watershed space worldwide.

Article Highlights

- We design a community participation evaluation framework for gauging the degree of community participation in a watershed space.
- Aiming watershed process reengineering, some critical organisational and management actions of a watershed project are identified and incorporated as the framework variables.
- We validate this framework through a primary field survey for making it adaptable in participatory mode.

1 Introduction

Most countries have adopted the Integrated Water Resource Management (IWRM) programme to promote coordinated development and water, land and related resource management (Biswas 2009). IWRM encompasses water systems' complexity, involving multiple factors and actors in multiple spatial and time scales (Carmona et al. 2013). Contextually, for achieving sustainable asset management transfer in water management, the predominant challenges are shifting from the technical domain to community management that demands socio-hydrological watershed modelling (Blair and Buytaert 2016; Jeong and Adamowski 2016; Seidl and Barthel 2017; Melsen et al. 2018).

While accepting the community's diversity and social inclusivity, watershed studies have extensively documented the centrality of community participation (CP) and identification of relevant parameters (D.Ridder, E. Mostert 2005; Pahl-Wostl 2015). In the past few decades, many new approaches have evolved, paving the way for new types of organisations, institutions and support system (Hamidov et al. 2015). Building societal resilience and protecting economic growth underpins the achievement of developmental agendas across many sectors, including health, energy, agriculture, environment, mining, and other industries. Consequently, the "water-energy-food nexus" approach that emerged in the late 2000s as a way of framing cross-sector and cross-scale interactions (Weitz et al. 2017) has gained momentum. This approach can address complex resource and development challenges and internalise social and environmental impacts (Middleton et al. 2015; Zhang et al. 2018; Geressu et al. 2020).

Many South-Asian countries are implementing IWRM through Integrated Watershed Management Programme (IWMP), employing community-based organisations (CBO) (IRMA 2014; D. Putuhena and Sapei 2015; Mondal et al. 2020). At the operational level, watershed managers encounter some critical questions: Why the community is not participating? How can the community knowledge and institutions be involved in the complexities of planning, designing and managing the water issues? How to build up a socially resilient community participation mechanism (CPM)?

The success of the watershed project correlates positively with the degree of effectiveness of CPM. So CPM must be an iterative and dynamic process with constant up-grading potential that can tune-up with the operational complexities.

Once Lord Kelvin (Saxon 2007) remarked that "When you cannot measure it when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." Likewise, one cannot upgrade a CPM if it can't be measure. So a tool for assessing the effectiveness of CPM is indispensable in watershed management. Policy-makers need readily available and easily manageable ways to deal with the new global scenario and bottom-up perspective (Crescenzi and Rodríguez-Pose 2011). An integrated conceptual toolkit that cross-fertilises bottom-up and top-down developmental policy practices is necessary rather than merely linking up indicators (2019).

In this study, we propose a methodology to build a community participation evaluation framework (CPEF) that would be reliable and valid for the entire watershed project life cycle to facilitate efficient strategic intervention to redirect and reengineer the CPM.

Here, some relevant questions arise: i) what would be the dimensionality of an integrated socially resilient CPEF, and ii) how to identify the most appropriate watershed domains and variables from the stakeholders' perspective?

There is a shortage of research in the area of integrated assessment of CP in watershed management. Acknowledging that a watershed is more of a socio-technical system than a geo-hydrological unit, researchers have sorted out various watershed parameters for facilitating CP. However, the majority of CPM assessment studies feature limited parameters or specific subscales.

Studying CP, Ehler enlisted four types of governance performance indicators: Input indicators, Process indicators, Output indicators and Outcome indicators (Ehler 2003). Evaluating the periodic performance of water user's association in Osh Province, Kyrgyzstan, Kazbekov et al. use four indicators: adequacy, efficiency, dependability and equity (Kazbekov et al. 2009).

To determine the factors that are disadvantageous to CP in irrigation management, Uysal and Atis (Uysal and Atış 2010) measured the periodic performance of irrigation water users associated with selected indicators like adequacy equity, utility, productivity, sustainability, financial efficiency and satisfaction. Their definition of performance includes (i) the degree to which an organisation's products and services respond to the users' need and (ii) the efficiency they use the resources. In examining CP in smallholder irrigation schemes in Zimbabwe, Mutambara et al. observed that low literacy and unsustainable livelihood sources leading to lack of involvement in development programmes have affected necessary community ownership and professional management (Mutambara et al. 2014). Similarly, Kurt Fedra emphasises net benefit from operation and use of water resource systems (Fedra 2015). By reviewing rural water supply schemes, Chukwuma examined community participation levels, based on the response towards functions assigned to the water committees, using descriptive statistics (Chukwuma 2016).

Further, some worthy CP analysis is noticeable in other fields that would be helpful in watershed management. Recognising that communities and organisations frequently form a collaborative relationship, Butterfoss and Kegler emphasised the need for a comprehensive understanding of community coalition (Butterfoss, Frances D. Kegler 2002). Discussing community coalition evaluation in promoting community health, Granner and Sharpe observed a dearth of research that develops measurement tools to assess effectiveness (Granner and Sharpe 2004). In comparing stakeholders' perception regarding success factors, Ng S. et al. have applied statistical analysis (Ng et al. 2012). Nicolic and Simonovic suggested a simulation method based on multidisciplinary approach to deal with complex water resource systems in a holistic way (Nikolic and Simonovic 2015).

Regarding product and service management, Kuvykaite and Tarute presented an analysis of consumer engagement dimensionality based on conceptual and empirical studies of consumer engagement (Kuvykaitė and Tarutė 2015). O'Brien et al. observed that the User Engagement Scale (UES) has become a widely used new tool to measure User Engagement in the digital domain (O'brien et al. 2018). Observing that "Engagement is more than user satisfaction", they fundamentally focused on the challenge of measuring reengagement for service redesigning and evaluation. To assess CP in Chinese cultural heritage management, Li et al. developed a targeted assessment framework (Li et al. 2020).

In designing an integrated CPEF for CPM evaluation, it is necessary to investigate combinations of conditions to accommodate maximum watershed parameters for improving inter-organisational partnership.

This research focuses on providing a better understanding of community policy agency and how watershed administration might promote and upgrade community engagement efforts. Our approach is theoretical-conceptual, drawing on existing literature on CP in integrated watershed management programmes (IWMP) project and empirical in that the specific variables are customised to a local context. This CPEF conceptualisation dwells around a multi-dimensional hypothesis resonated within the community in its entirety. The dimensions broadly include linking property rights to watershed assets, scoping social learning, and incorporating legal, developmental, economic and environmental actions.

Because of that, this study applies a project–comprehensive survey in IWMP project areas in the Brahmaputra valley in Assam (India) to explore, validate and filter the significant variables for obtaining a CPM measuring tool. We have identified the dimensionalities (constructs), domains and variables for a hypothetical CPEF, encompassing the sets of significant organisational functionalities and operational management actions — useable for the entire IWMP project life cycle. We perceive that since a watershed project operates through a network of organisations with prescribed management actions, the organisational actions (OA) and critical management actions (CMA) of the project managers would constitute the domains and variables of the CPEF.

However, a significant challenge in developing a useful evaluation tool is that it should be robust enough to gauge the degree of agreement in stakeholders' perceptions and resilient enough for synchronisation with the involved communities' changing requirements. That demands the CPEF to be usable through bottom-up or participatory mode. Hence we propose a CPEF appropriate for participatory mode, contrary to the prevalent top-down assessment procedures. In any IWRM programmes, a participatory CPEF can be a convenient instrument to review CPM from the users' perspective. It would help to monitor the gap between the perception of watershed policy experts and field level stakeholders, which is ever-present in propagating an effective CPM. Watershed managers practising IWRM in any country can apply similar CPEF with modifications adapted to their local context.

2 Materials And Methods

Research Framework

Figure 1 shows a summary of the research procedures and methods to achieve the stipulated research aim

In every IWMP, the CPM permeates through all organisational components. So, we explored the scoping conditions of the CPEF to include all key watershed governance actions. We derived lessons from literature and the existing organisational models focusing on the watershed zones' local socio-political environment to ascertain the definitions, characteristics, benefits, and watershed CPM risks. To classify relevant indicators and propose appropriate critical actions for a hypothetical CPEF, we identified entangled social groups and their interactions. Following an iterative research process where theories are gradually adjusted based on realistic situations, we constructed arguments around theories of collective actions and participatory governance for resource management as dominant concepts.

Figure 2 shows different steps of the framework development. Figure 3 shows the CPEF structure.

Constructs, Domains and Variables for the CPEF

In designing the variables for the CPEF, we assumed existing social group formation procedures, interdependence and standard management transactions prevailing in IWMP projects. Generally, watershed projects utilise two prime apparatus to accomplish CP, (a) organisational management and (b) critical component management. We mapped the domains and variables from these two perspectives (Figure 4) to propose two structural constructs of the CPEF: Organizational Construct and Managerial Construct.

We conducted pilot interviews with academicians, water resource officers to seek their expert opinions in selecting the CPEF domains and variables. This pilot study would add value to the research and help move to the next data collection stage.

Identifying IWMP-OAs

The performance of a watershed project hinges on the water managers' ability to link property rights of the created assets to the community. Inability to delineate property rights in the projects results in improper risk-sharing modalities leading to a vicious cycle of project failure. The failure to link the community with the public projects is the fallout of the inability to define property right of the created assets for effective management transfer (Furubotn and Pejovich 1972). Community participation through coalitions facilitates ownership and increases successful institutionalisation into the community (Bracht and Tsouros 1990). Vermillion substantiated the impact of property right on infrastructure development as: "Property rights are primarily social conceptions, but to have thrust on human behaviour, they must be enforceable through sanctions. Sanctions may involve new legal codes, punishments imposed by users' groups or other social pressures. Key obligations which may be attached to property rights are financing construction and maintenance of infrastructure, financing costs of service provision, and following rules regarding use or protection of the resource" (Vermillion 2001).

Studying water right reform in China, Calow et al. (Calow et al. 2009) concluded that the development of a modern water rights system is vital for meeting water conservation and reallocation objectives. Resources allocation are more efficient, where transparent markets for property rights are established (Grimsey and Lewis 2005). Podder et al. compared irrigation reform in India and Australia. They observed that in transferring ownership and management for the distribution of infrastructure in Australia, a significant change in production occurred due to a change in institutional structure underpinned with a transfer of property rights from state governments to either individual irrigators or collectives irrigators (Poddar et al. 2011). In formulating a robust CPEF having the potential of positive economic impact, few relevant questions are: how to attach property rights to the created assets and how to accomplish risk allocation for devolution of the community's management functions. The effectiveness of watershed CPM must be computable from this perspective. Therefore, we included OAs concerning property rights transfer in the CPEF.

Subsequently, our organisational construct consisted of different domains, representing one active project-level organisational element (Table 1). It accommodates the desirable organisational procedures or actions involved in the organisational management, which we denoted as 'Integrated Watershed Management Programme-Organisational Actions' (IWMP-OAs).

Table 1 Participant CBOs and their activities in the present organisational model of IWMP projects

IWMP Participants	Members	Defined Role
Watershed Development Team (WDT)	At least four members from the public sector	It is providing technical assistance to the watershed activities and overseeing project implementation.
Watershed Development Committee (WDC)	Ten members from the project area	Selection of CBOs, project implementation activities
Self Help Group (SHG)	Village producers CBOs	Implementation of livelihood schemes
Villages/Users	Users of the watershed activities	The beneficiary of the project
Gram Sabha	Elected local government	Formation of WDC in collaboration with the PIA

Identifying IWMP CMAs

Identification of the critical management actions is very challenging for 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. So the CPEF should assess and compare the IWMP operational dynamics at different phases of the project life cycle to take care of the participants' expectations. Studying PPP projects, Ozdoganm and Birgonul divided the critical factors into four main groups i) Financial, ii) Political and legal, iii) Technical, iv) Social (Ozdoganm and Talat Birgonul 2000). In this grouping method, Ng S. et al. have added another factor related to staff issue and success factors (Ng et al. 2012). Similarly, we have included some relevant watershed doctrines and critical issues in formulating the managerial construct's domains and variables, which watershed managers often overlook in outlining CMAs.

In IWMP, environmental issues constitute another significant domain. The Ontario Environmental Assessment Act defines environment as a) Physical features (land, air, water), b) Man-made devices and things (building, 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) (Government of Ontario 1980). Again, Sadler extended Environmental Assessment to include: Environmental Assessment (EA), Economic Impact Assessment (EIA), Social Impact Assessment (SIA), Strategic Environmental Assessment (SEA) (Sadler et al. 1996). 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 (Isobel W. Heathcote 2009).

Moreover, in watershed operations, the legal factors are primarily influential. 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 and Gonzalez-Villarreal 1999). Water-managers must resolve conflicts smoothly within the boundaries of sanctioned social behaviours. Their rules reflect a social consensus on conflict resolution's two principal elements: compensation and punishment (Isobel W. Heathcote 2009). Referring to water management in the USA and Canada, Heathcote (2009:309) acknowledged that besides written laws, there are influential inherent common law rights and responsibilities such as nuisance, riparian rights, and strict liability, trespass, and negligence. Heathcote further noted that an important social dimension of water rights, closely associated with the resource's economic dimension, is a definite intent in most legislation to prevent water hoarding, speculation, monopolies, and waste. In many countries, the legal system's basis is written-law or statutes, which fall short of solving many local disputes in IWMP projects. There is a broader scope of applicability of common law rights and responsibilities for better community engagement in this context. Accordingly, the CPEF includes CMAs relating the common laws for better social control and infusion.

Long term and sustainable financial gain is the focal point in IWMP planning. All IWMP projects must embrace appropriate financial management actions since their financial appeal is a strong determinant to generate better CP.

A community is a cultural group. Its institutions evolve through the socio-cultural values intrinsic to the community. Besides, every culture group has its history, origin, development, migrations, conflicts, adjustments (Pauline v. Young 2000). Sadler (Sadler et al. 1996) emphasised social impact assessment (SIA) with environmental assessment.

Post project monitoring and follow up is an essential component of IWMP management. Reliable monitoring and follow-up system help determine compliance, identify any unforeseen effect, 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 key factors for resilient water infrastructure. For resilience against the political and institutional instability, Hurford et al. endorsed the necessity of 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 (Pahl-Wostl et al. 2008). To do away with the deep uncertainties of social behaviour and exogenous events, Walker et al. (Walker et al. 2015) suggested incorporating flexibility and learning mechanism in water management. However, questions may arise: Is it over-ambitious to incorporate social learning and building new social behaviour through IWMP? Or, how far IWMP can shoulder responsibility for propagating social learning? In answering this, it's noteworthy to quote Wehn et al. (Wehn et al., 2018): "The facilitators are not accountable if stakeholder engagement fails in terms of social learning, but they are responsible for ensuring that the enabling conditions for social learning are accessible." The present-day water managers must not overlook this point.

Based on these perspectives, our managerial construct encompassed different domains of CMAs, each representing a category of CMAs. In the CPEF, we denote them as 'Integrated Watershed Management Programme-Critical Management Actions' (IWMP-CMAs), while each CMA is taken-up as an individual variable.

Brief Description of Study Area

For validating the CPEF, we identified the active interactions in CPM of four IWMP projects in the state of Assam, India. They are 1. Kaldia IWMP part III 2010-11 (SLNA 2010a), 2. Turkunijan IWMP 2010 (SLNA 2010b), 3. Satpokholi IWMP 2011-12 (SLNA 2011), 4. Maloibari IWMP 2010-11, (SLNA 2010c) (Fig. 5,6,7 in appendix). We purposively selected these watershed projects within the same agro-climatic zone functioning with similar operating procedures to be laboratories for the investigation.

The projects under IWMP have primary objectives for achieving sustainable community participation in watershed management (SLNA 2010b). The Indian planning authority, NITI Aayog, has formed the State Level Nodal Agency (SLNA Assam) 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 work in collaboration with the local government organisations like Zila Parishads, Gaon Panchayatas, and CBOs (Table 1).

The IWMP-Assam envisages the implementation of IWMP with a declared prescription of formal allocation of users' right on common property (2011).

Data Collection Framework

A structured questionnaire protocol is designed based on the variables. A questionnaire survey and expert interviews were conducted to glean information and perceptions of 30 experienced project stakeholders relating to these variables. We have chosen the survey participants from two groups using a stratified sampling approach: i) Watershed Policy Experts and ii) Field level Managers and community. However, 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 (Table 2 in appendix). Our justification for choosing the two groups is that, in enhancing community participation, there appears a large gap between the perception of theoretical experts and field level stakeholders.

The questionnaire was directly distributed to the individuals. They are asked to record their agreement using a 2-point scale. Researchers are counting created assets where responses are mostly quantitative in a conventional non-participatory (top-down) watershed assessment method. But here, we are going to measure community participation from the stakeholders' perspective (bottom-up). So, we need to assess their general qualitative attitudes towards watershed management actions. Accordingly, our community participation measuring framework is applicable in a participatory model where many respondents are community people. In this context, the 2 point scale would accommodate their opinions in a better way.

In the survey, a questionnaire based on the concept of watershed management and the research objectives are incorporated to mark their opinion by choosing 2 when they agree and 1 when they disagree. (Table 3 in appendix).

Data Analysis Framework

For analysing and filtering the variables, we adopted suitable non-parametric statistical techniques as listed in Table 4.

Table 4
Statistical methods applied

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

Limitation

While our theoretical framing epicentres contribution to social capital, we do not explicitly address broader cultural context and local politics. We also did not address any explanation that relates personal skill, efficiency and educational qualification of members of the CBOs.

3 Results

The Hypothetical CPEF

Looking into an IWMP project's organisational actions, the CPEF is framed on two constructs (Figure 8)

Domains and Variables of Organizational Construct

We have identified the five domains of IWMP-OAs encompassing all institutional components in Organizational Construct. They are: i) Organizational Action1-Gram Sabha Operation (OA1-GS Operation), ii) Organizational Action2-Water Users' Group Actions (OA-2-WUG Operation), iii) Organizational Action3-Watershed Development Council Operation (OA1-WDC Operation), iv) Organizational Operation4-Watershed Development Team Operation(OA4-WDT Operation, v) Organizational Action5-Self-help Group Operation (OA5-SHG Operation) (Fig. 9).

The five domains encompass the IWMP-OAs necessary for better role allocation functionality in the five organisational elements (Table 1).

The IWMP project area must include all the villages of the basin. Moreover, effective CPM results in active villages, where the villagers are enthusiastic and willing to continue in IWMP activities. So, for the domain' OA1-GS operation,' we propose 'the numbers of villages covered' and 'villagers' enthusiasm and willingness to continue' as essential OAs.

For the domain' OA2-WUG Operations', we suggest that a CPM's success depends upon employing a proper mode of selection, a merit-based selection process, and keeping a provision of developmental training. Besides, users' willingness to continue is a reflection of better participation. Accordingly, we propose IWMP-OAs in this domain.

Similar kinds of variables are also relevant in the domain 'OA3-WDC Operation'.

The WDT is the primary organisation for the scheduled watershed activities like planning, budgeting, implementing, and auditing the 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, we choose OAs for the domain, 'OA4-WDT Operations'.

Regarding domain 'OA5-SHG Operations', we can measure the degree of participation by looking into how actively the members associate and how much 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.

Domains and Variables of Managerial Construct

The Managerial Construct covers the IWMP-CMAs, which the project managers should employ continuously throughout the project life cycle. We grouped these CMAs into eight domains (Fig. 7).

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. The mode of asset transfers and, therefore, the role allocation and authority sharing, the existence of 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 technicality very complicated and must be manageable by the community. Whenever the service quality is well-defined and measurable, only there can be scheduled, differential and timely service. Therefore, 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. We incorporate the related CMAs as variables in 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 about computing the B/C ratio and implementing accounting and auditing policies. The community's belief about 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, scopes for private funding in the project are crucial for engaging the participants.

The CMA5-Economic domain includes various economic activities for the local communities. The economic impact in meeting long term demand reflects the success of an IWMP project. Again positive impact is possible only when the planners initiate 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 economic auditing in the project area. From this standpoint, we have identified pertinent economic variables for the CPEF.

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

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

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

Thus, we identified 20 IWMP-OAs (variables) in the organisational construct and 45 IWMP-CMAs (variables) in the managerial construct. These are shown in the hypothetical CPEF (Table 4 in appendix).

Statistical Results and Rejected Variables

We have put our data to various statistical tests to achieve ethical acceptability of the variables in the CPEF. Table 5 shows the applied tests and obtained values.

Table 5
The applied tests and obtained values

Test for	Involved Group	Values of Statistical Coefficients/ p-values	Observations/ Inferrences
Interrater Reliability	Gr1	Kalpha = 0.56904	15% below the acceptable limit. Low reliability
	Gr2	Kalpha = 0.92684	Acceptable Reliability
In-group Consistency	Gr1	α = 0.94	High
	Gr2	α = 1.00	Excellent
Inter-group Correlation	Both	r = 0.78820548 Obtained p-value 0	The correlation is positive and strong
Validity by measuring the Degree of Alignment of inter-group views/perception	Both	A) ρ = 0.88101521 Obtained p-value = 0 B) $\rho^2 = 0.7762$	A) The degree of agreement is positive and strong. B) 77.62% of respondents have agreed on variables acceptance C) It is higher than the critical rho value (Here, ρ −crit = 0.245) from Spearman's table at 95% confidence level.
Validity by measuring Agreement Level	Gr1	84.62%	Strong agreement level
	Gr2	80%	Strong agreement level
	Both	80%	Strong agreement level
The similarity of Agreement Score Mean	Both	Obtained 2-tailed t-test p-value 0.07966964(at 95% confidence level, t-stat = 1.770141, t-crit = 1.983321, df = 102.7528)	We cannot reject the H_0, and hence the mean is statistically similar.
Filtering of Accepted Variables	Gr1	Obtained CoV values are zero or other than zero.	Rejected Variables Q4-OA2-b, Q8-OA3-b, Q11-OA4-a, Q22-CMA1-b, Q25-CMA2-c, Q26-CMA2-d, Q47-CMA5-e, Q54-CMA6-e, Q65-CMA8-f
	Gr2	Obtained CoV values are zero or other than zero.	Rejected Variables Q7-OA3-a, Q14-OA4-d, Q42-CMA4-g, Q44-CMA5-b, Q47-CMA5-e

Test for	Involved Group	Values of Statistical Coefficients/ p-values	Observations/ Inferrences
	Gr1	Obtained 2-tailed t-test p-value 0.00273483(at 95% confidence level, t-stat = 3.117133, t-crit = 1.99773, df = 64)	We can reject the $H_{0,}$ and hence the CoV values are statistically dissimilar or other than zero.
	Gr2	Obtained 2-tailed t-test p-value 0.03005308(at 95% confidence level, t-stat = 2.218806, t-crit = 1.983321, df = 64)	We can reject the $H_{0,}$ and hence the CoV values are statistically dissimilar or other than zero.

Kalpha shows inter-rater reliability between the two selected groups of raters. Its advantages are: a) It ignores missing data, b) Can handle various sample sizes, categories and numbers of raters, c) Applies to any measurement levels (i.e. nominal., ordinal, interval and ratio). For Gr1, Kalpha (0.56904) is about 15% below the desirable limit. The low value reflects the disparity of agreement between the persons in the Gr1 that includes 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 (0.92684) shows a good agreement amongst the raters.

The measure of internal consistency or scale reliability 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.

In measuring the correlation between the inter-group scores, the alpha coefficient value, 0.78820548, 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. We detected: A) the ρ value (0.88101521) 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.

Out of the 65 variables, the numbers of variables with agreement and disagreement is shown in Figure 11, 12 and 13. The percentage agreement shows 80%, 84.62% and 80% of the selected variables are agreed upon by both groups, Gr1 and Gr2 respondents, respectively (Figure 14, 15 and 16). On this excellent agreement score, we can conclude that the variables list is acceptable and valid for the CPEF. Practically, the agreement score of the selected groups should be statistically similar. We ascertained it by two samples T-test on average agreement score of both Groups. The p-value of 0.07966964 (at 95% confidence level, 2-tailed) indicates that the mean score is statistically similar.In the CPEF, the variables having the most robust agreement scores are desirable. We calculated the CoV of each variable separately for each group for filtering out the least robust variables. We decided to reject the variables with CoV values greater than zero. The rejected variables are placed in Table 6.

Table 6
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	0.3590351654	0	56	55
The proper mode of selection for WDC	Q7-OA3-a	0	0.1664092663	1	48
Merit-based selection of WDC	Q8-OA3-b	0.3379154498	0	52	52
The proper mode of WDT formation	Q11-OA4-a	0.1579345138	0	48	50
Participation of WDT in planning and budgeting	Q14-OA4-d	0	0.2852730279	1	46
Contract flexibility between providers and participants	Q22-CMA1-b	0.3590351654	0	39	40
Provision of definite and measurable service quality	Q25-CMA2-c	0.3699849847	0	39	38
Managers' concern for power availability	Q26-CMA2-d	0.2224859546	0	36	38
Scope for private funding in the project	Q42-CMA4-g	0	0.362950869	24	20
Existence of demand forecasting in project planning	Q44-CMA5-b	0	0.3581610266	1	19
Scope of common-pool resource management	Q47-CMA5-e	0.3670066451	0.2179449472	19	17
Scoping for social return on investment	Q54-CMA6-e	0.3590351654	0	11	11
Introduction of rating policy	Q65-CMA8-f	0.3590351654	0	1	1
Total Numbers of rejected variables out of a total of 65 variables	13	9	5		

List of rejected variables and acceptance level of the CPEF by CoV Score				
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 variable serial number in the entire list, the second part denotes the construct followed by domain number, and the third part denotes variable number in its domain)

Further, for confirmation, we tested whether the CoV values of the rejected variables are statistically dissimilar or other than zero by a one-sample t-test on CoV values, taking the hypothetical mean to be 0. We obtained the p-values (at 95% confidence level, 2-tailed) are 0.00273483 and 0.03005308 for Gr1 and Gr2. Since both p-values<0.5, hence we can reject these variables. From the CoV score, it is seen that out of the total 65 variables in the hypothetical CPEF, the numbers of variables rejected by both group are 13. Out of these, Group-1 has rejected nine, and Group-2 has rejected five variables (Figure 17). Again, it is seen that 80% of the total 65 variables are agreed upon by the stakeholders. So, we can conclude that the acceptance level of the hypothetical CPEF. Moreover, we can see that the acceptance level of group-1 is 86.15, and that of group-2 is 92.13 (Figure 18).

Summarising all the results, we can exclude the rejected actions to obtain the most agreed-upon set of actions for the final CPEF.

4 Discussion

In the first place, aiming to design a CP measuring tool for watershed projects, we have developed a hypothetical watershed CPEF from a socio-hydrological perspective. As the reliability and validity of a measuring tool are of the initial interest, we have checked these attributes of the CPEF through various statistical analyses on collected primary data. After statistically checking the robustness of variables, we obtain the most accepted watershed management actions set. We have determined the acceptance level of the developed CPEF. In any watershed space, managers can adopt the same methodology and perspectives to formulate their CPEF.

Similarly, they have to choose the variables adaptive to the local context. Using a validated CPEF, they can determine the acceptance level of the current CPM. Then by excluding the rejected variables, they can build up a more socially resilient CPM.

Our objective was to make a CPEF robust enough to evaluate watershed managers' total endeavours in achieving better community participation. Subsequently, in the CPEF, we have incorporated the most significant organisational and critical management actions associated with social wellbeing and economic prosperity in the watershed space. This framework's uniqueness is that departing from subscale development for CP evaluation like the previous researchers. We propose an integrated bottom-up CPEF.

The developed CPEF can throw new light on a current CPM's bottleneck, which often goes undetected. The rejected variables and the degree of non-alignment of stakeholders' perception would increase the ability to compare community and government links. This methodology can also be adapted to any IWMP project as a convenient benchmarking and substantiating tool applicable through participatory appraisal (bottom-up) mode.

It is mostly seen that the 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 many essential watershed indicators and benchmarks for incorporating the project objectives with a project-specific baseline for target achievement (2011). They emphasised reporting achievements like "Total number of assets created under IWMP," "Total irrigated command area," and so on. Another significant objective of the Aayog is social audit and process monitoring in watershed projects. But in the absence of top-down appraisal policy, many ambitious procedures become mere bureaucratic measures that usually show dubious appraisals skewed from reality and disengage the community. Therefore it is vital to accommodate appraisal indicators from a participatory or bottom-up perspective. Hopefully, our framework might be useful as a metric for continuous & 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 CPM. Therefore, this model evaluation framework would improve community engagement for system redirecting, goal articulation and sustainability in similar watershed spaces.

5 Conclusion

We 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 their resources. This research's value will be to inform governments and participants on reorganising resource planning and service delivery at a policy level.

This paper shows that real knowledge for continued learning can be acquired to re-capture the capacity to implement social policy. The CPEF, as a tool, owns an excellent potential for inseminating good social behaviours obtainable through observation and imitation of best management practices in the IWMP project areas. With proper implementation of a participatory tool like this one, new behaviour and motivation may evolve merely through practising and following-up, even without direct coercion. We recommend that the focus on best practices management embedded in the developed CPEF will initiate later research on social learning in watershed management.

For recording the usually unquantifiable level of stakeholders' perception, we are using some structured questions with a 2 point scale so that the answers reflect the respondents' view. Then to measure the difference in opinion, we are using relevant statistical tests. This methodology might be applicable for auditing and remodelling community engagement endeavours in any other field of study. While working with this CPEF model, any future researcher, policy-maker, or water manager may include larger numbers of community groups as respondents.

Declarations

Funding

No funding was received for conducting this study.

Conflict of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Availability of data and materials

We have used primary field data collected by field survey. All data generated or analysed during this study are included in this published article [and the supplementary information files].

Code availability

We have used commonly available Real Statistics software and Microsoft Excel tools for data analysis. The applied statistical tests have full acceptance in the research community.

Authors’ contribution

Conceptualization: Bhabesh Mahanta, Arup Kumar Sarma and Sashindra Kumar Kakoty. Methodology: Bhabesh Mahanta, Arup Kumar Sarma and Sashindra Kumar Kakoty. Formal analysis and investigation: Bhabesh Mahanta. Writing - original draft preparation: Bhabesh Mahanta; Writing - review and editing: Bhabesh Mahanta, Arup Kumar Sarma and Sashindra Kumar Kakoty. Funding acquisition: [Does not Arise]; Resources: Bhabesh Mahanta, Arup Kumar Sarma and Sashindra Kumar Kakoty. Supervision: Arup Kumar Sarma and Sashindra Kumar Kakoty.

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Bhabesh Mahanta, Arup Kumar Sarma and Sashindra Kumar Kakoty. The first draft of the manuscript was written by Bhabesh Mahanta and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Bhabesh Mahanta is the corresponding author.

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Tables

Tables 2-4 are available as an appendix in the supplementary file section

Figures

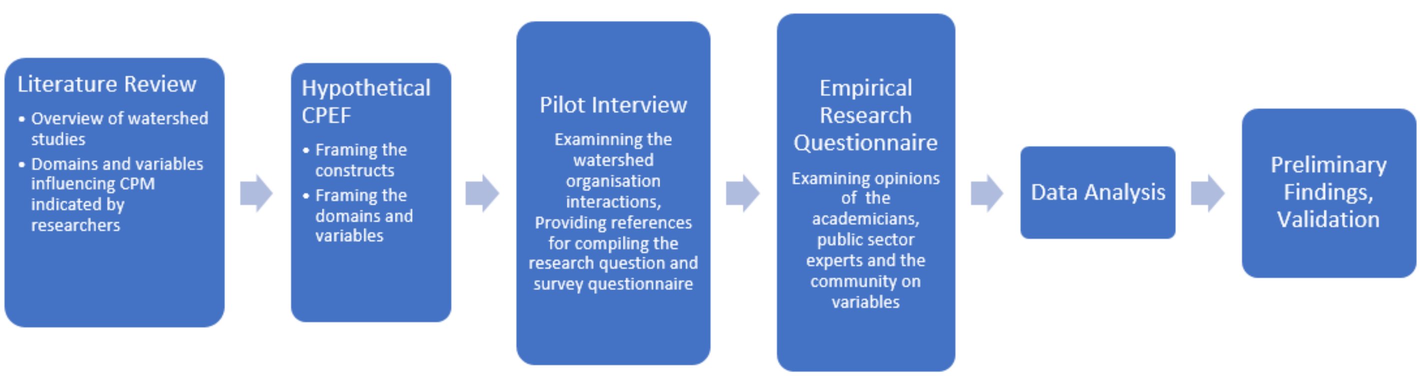


Figure 1

Research Process Flow Diagrams

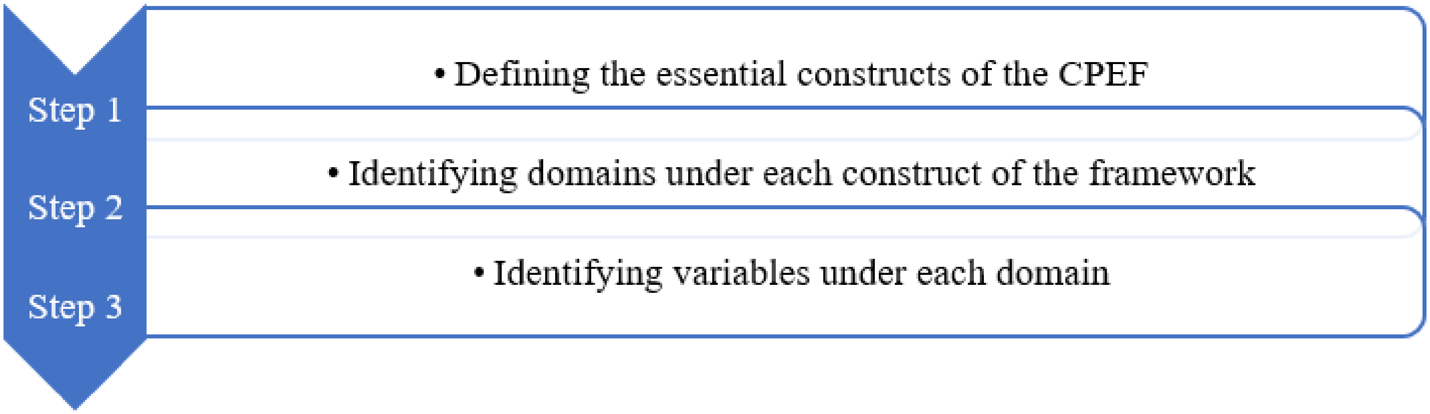


Figure 2

Steps for Developing the CPEF

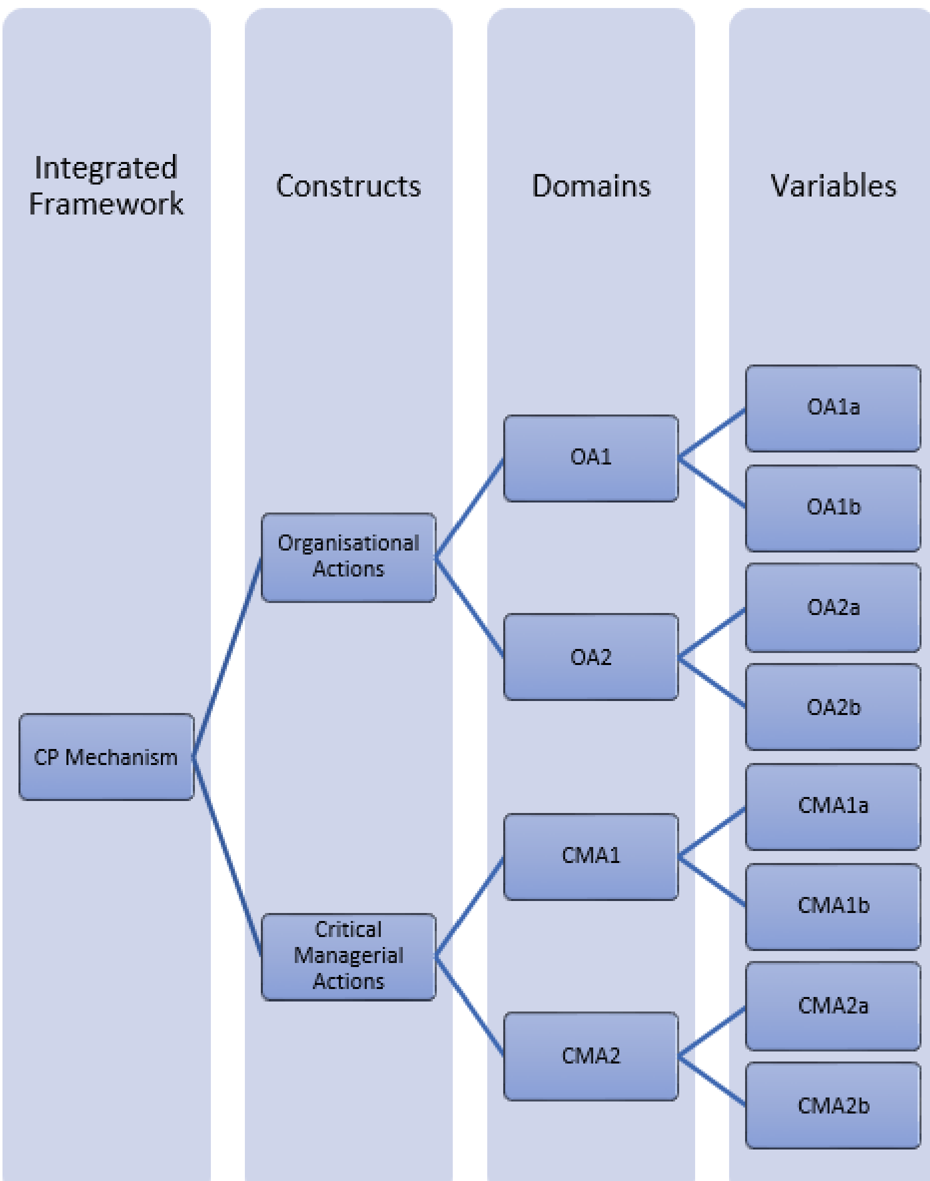


Figure 3

Format of Structure of the CPEF

Perspective I	Perspective II
• Mapping domains and variables pertaining to behaviours of IWMP organizational components (IWMP-OA)	• Mapping domains and variables pertaining to IWMP critical management actions (IWMP-CMA)

Figure 4

Two perspectives for mapping domains and variables

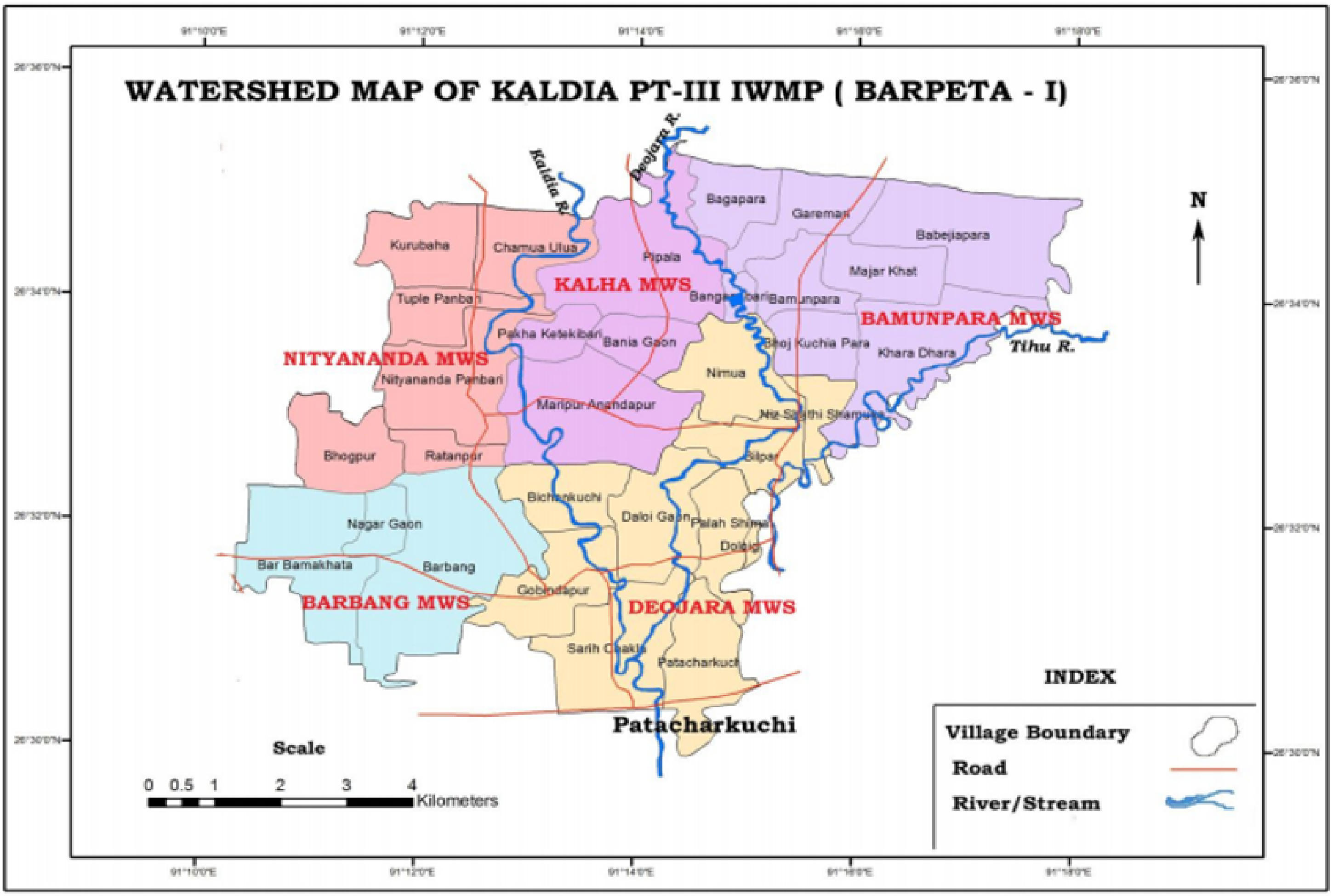


Figure 5

Map of Kaldia pt III IWMP (SLNA, I W M P 2010a)

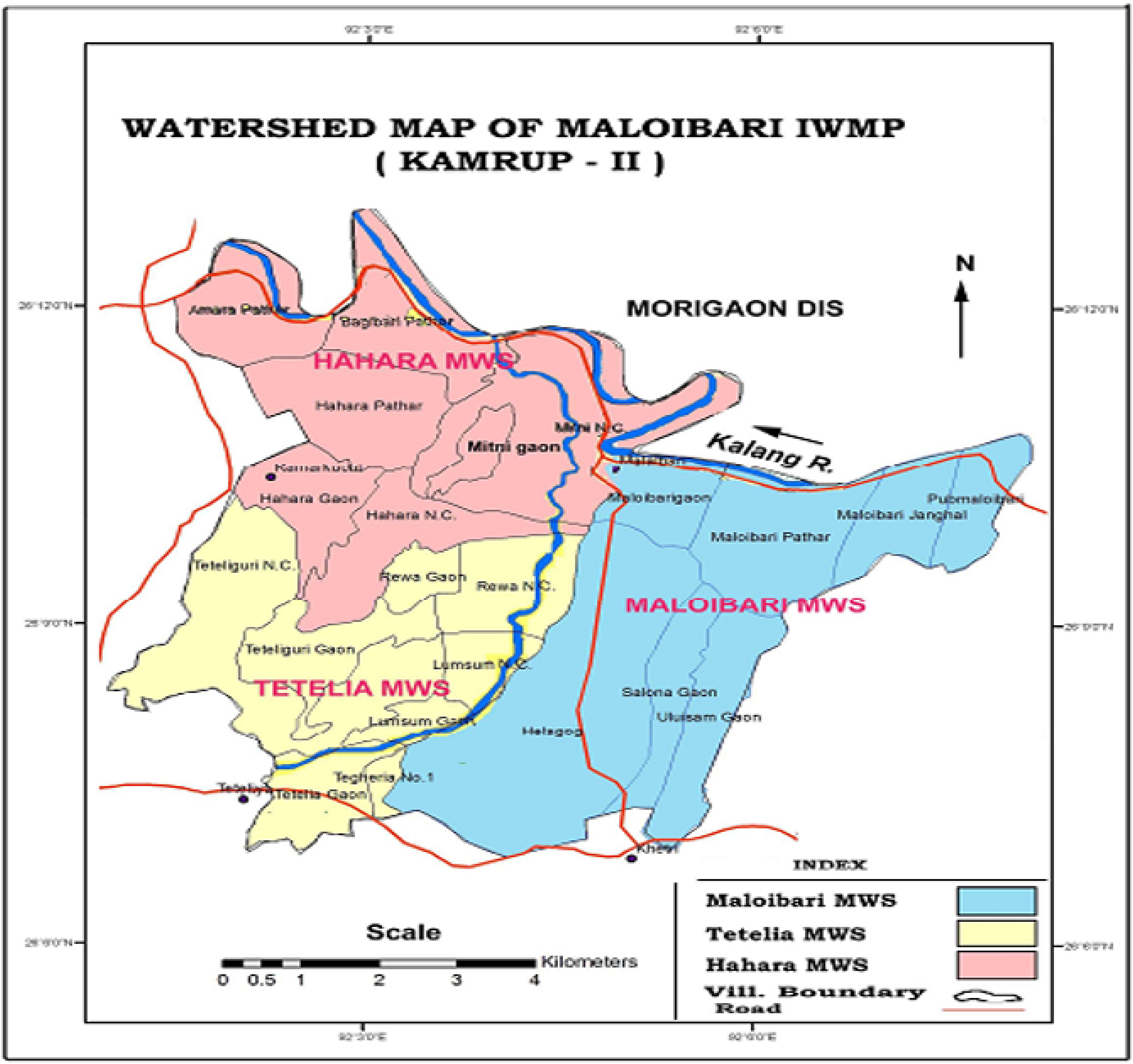
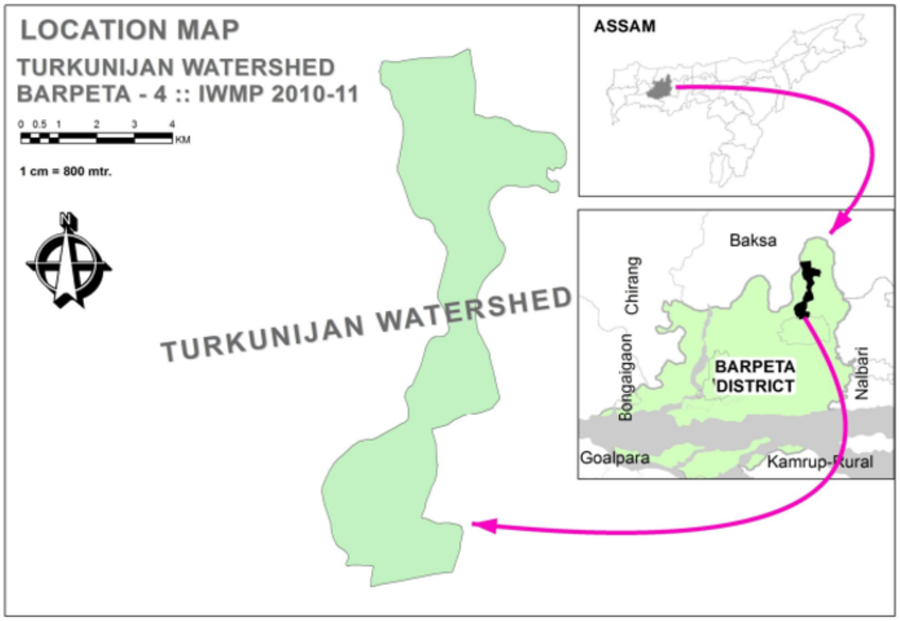


Figure 6

Map of Maloibari IWMP (SLNA, I W M P 2010b)



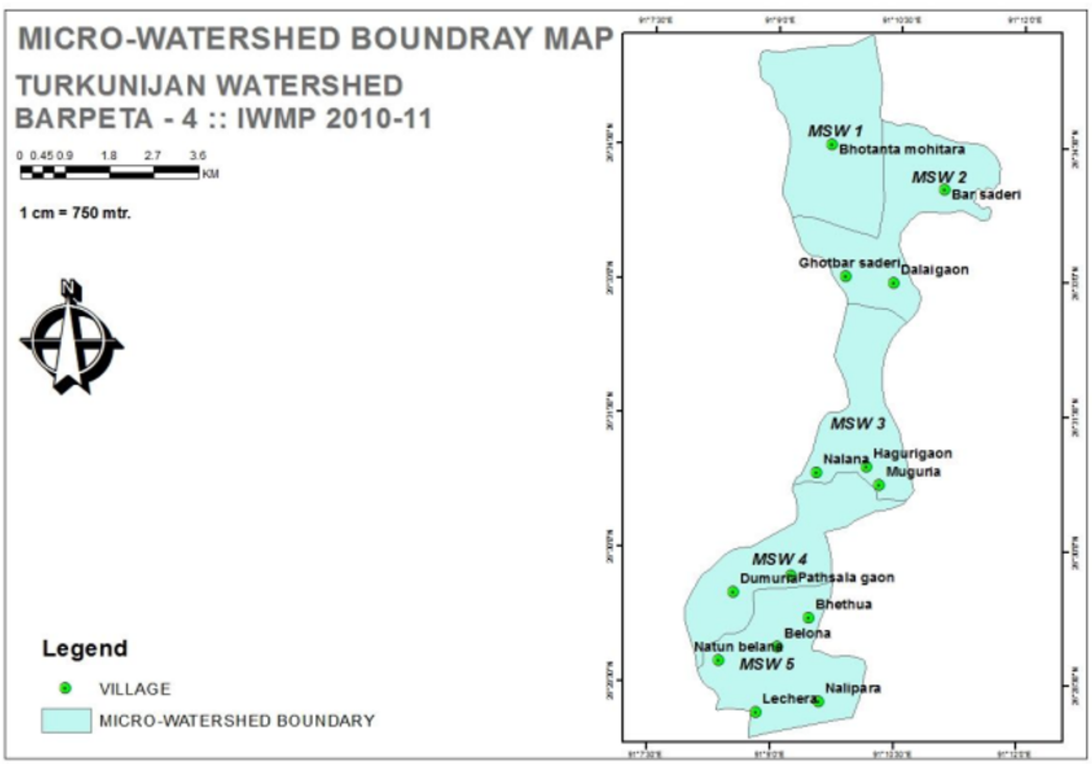


Figure 7

Map of Turkunijan IWMP (SLNA, I W M P 2010c)

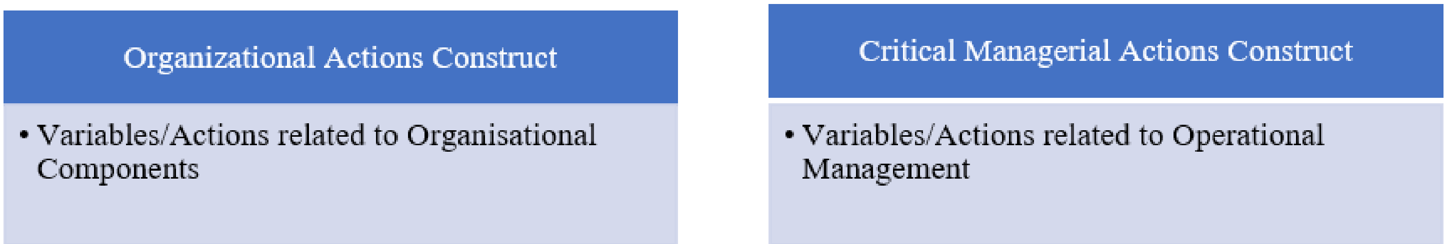


Figure 8

Constructs of the CPEF

Figure 9

Domains of the organizational construct

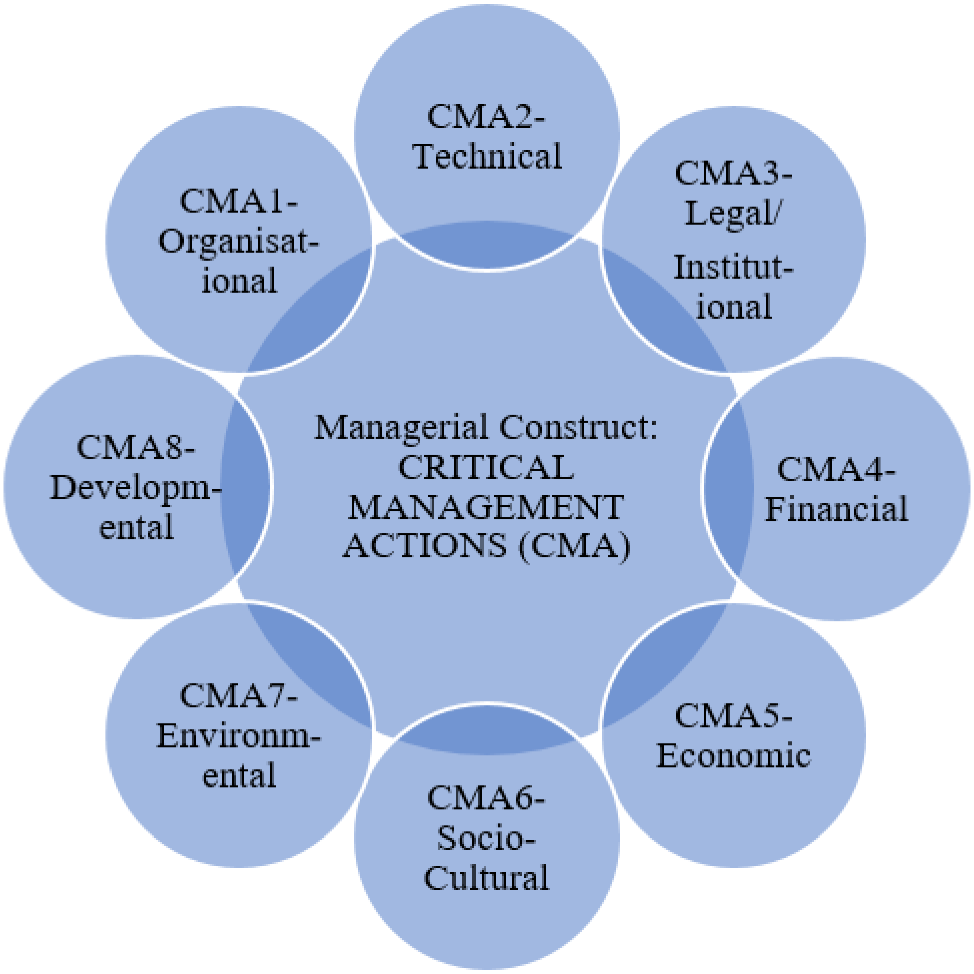


Figure 10

Domains of Managerial Construct

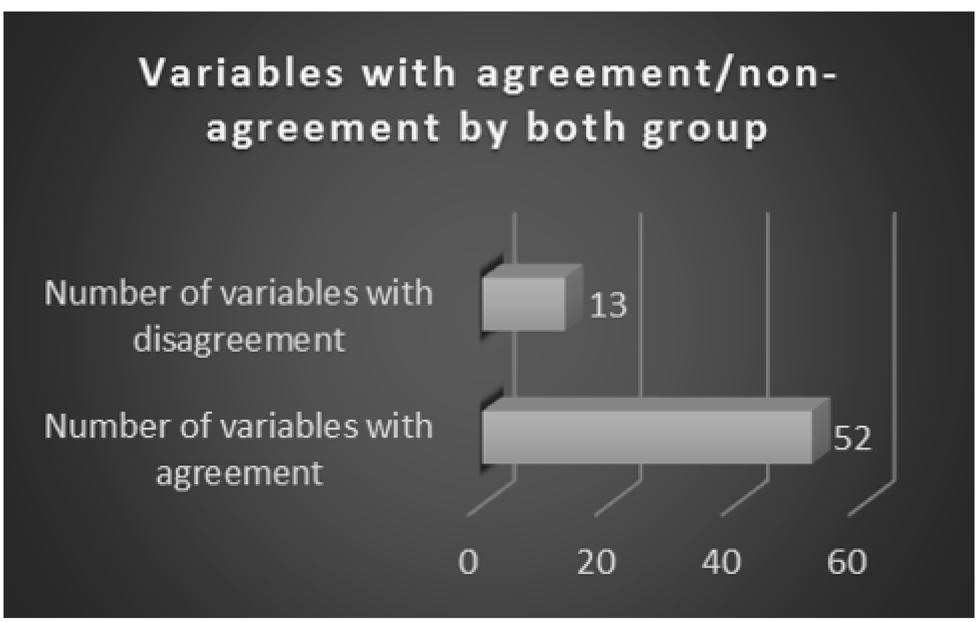


Figure 11

Agreement level by both groups

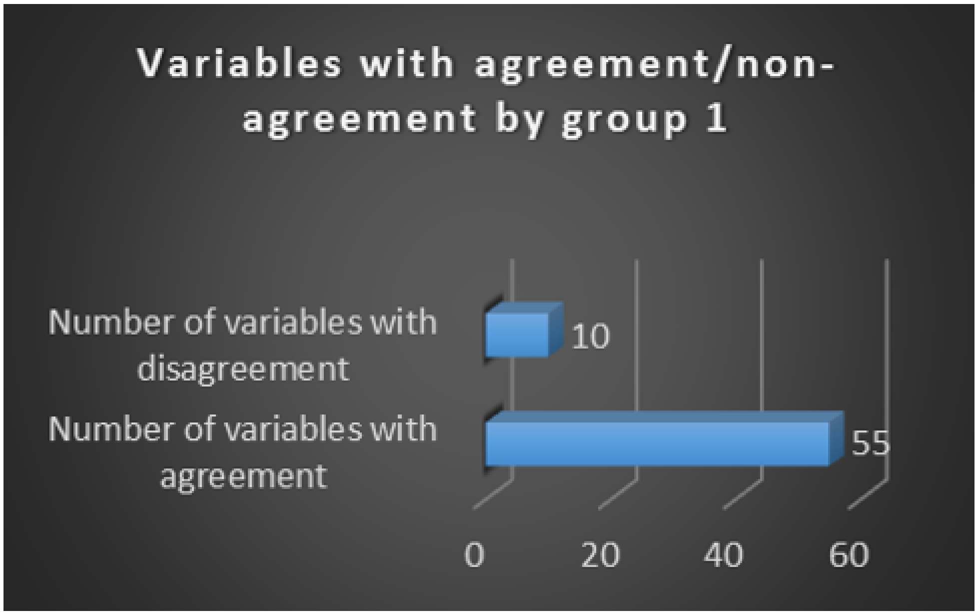


Figure 12

Agreement level by group 1

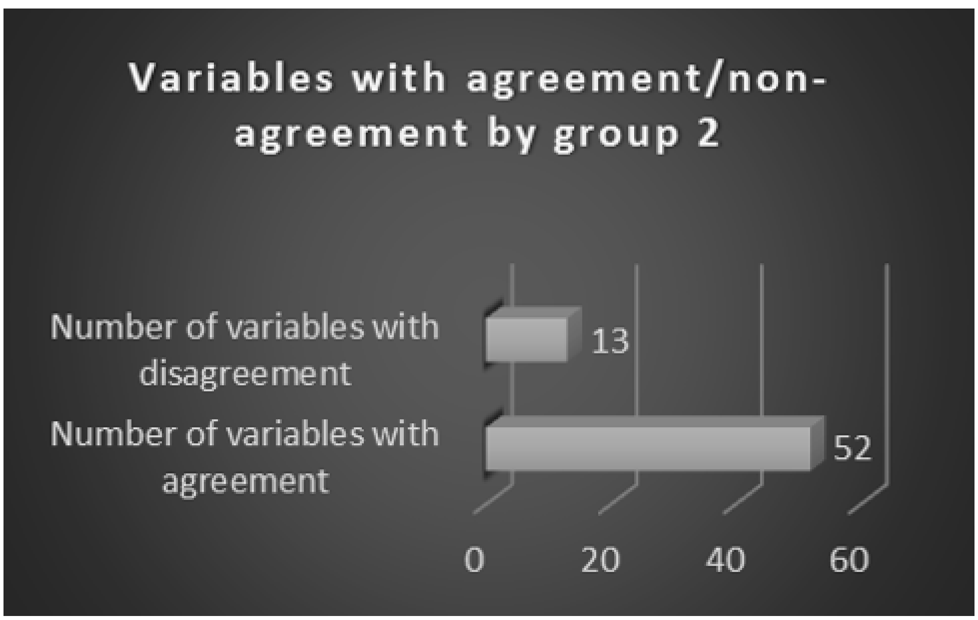


Figure 13

Agreement level by group 2

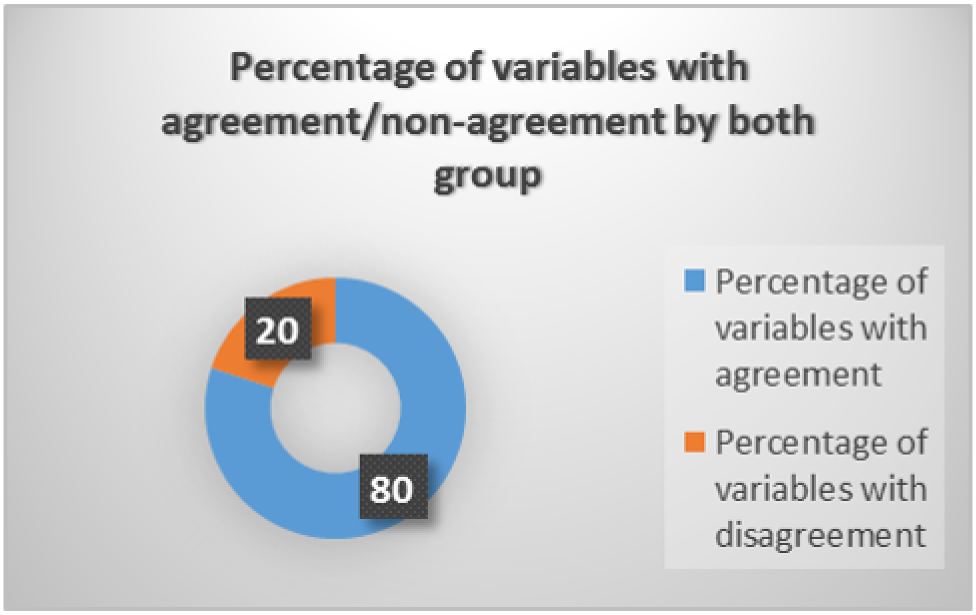


Figure 14

Agreement score by both groups

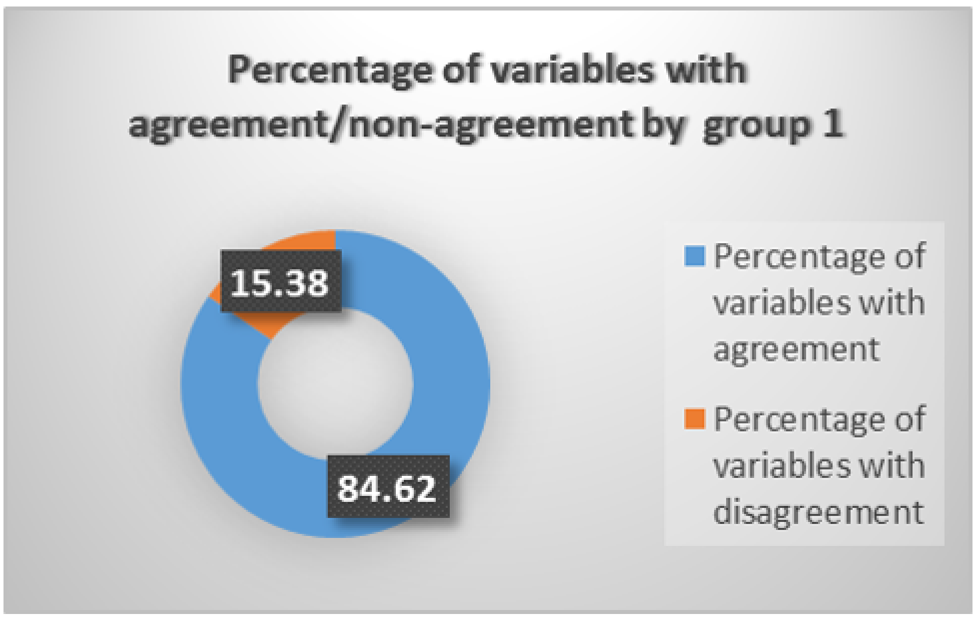


Figure 15

Agreement score by group 1

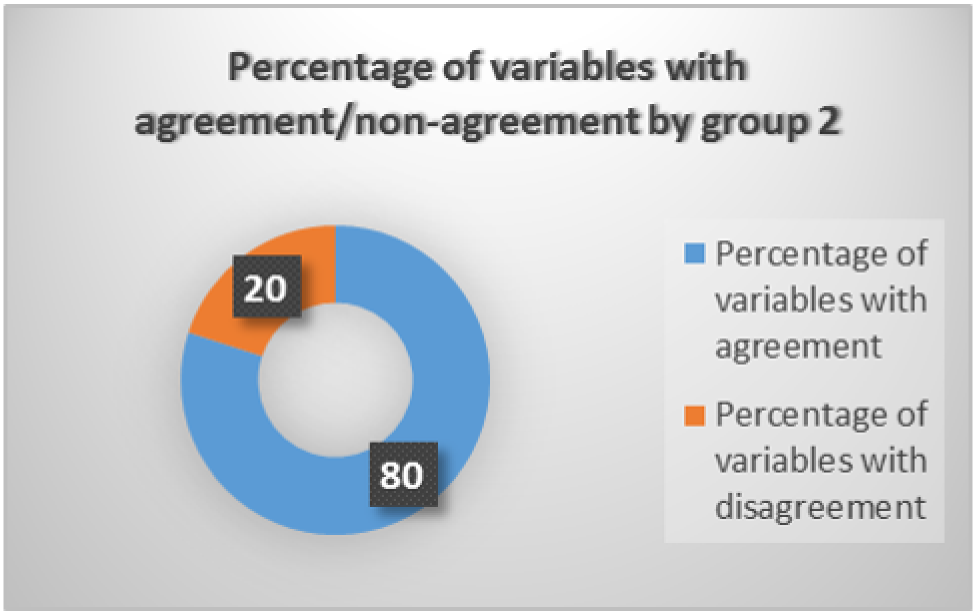


Figure 16

Agreement score by group 2

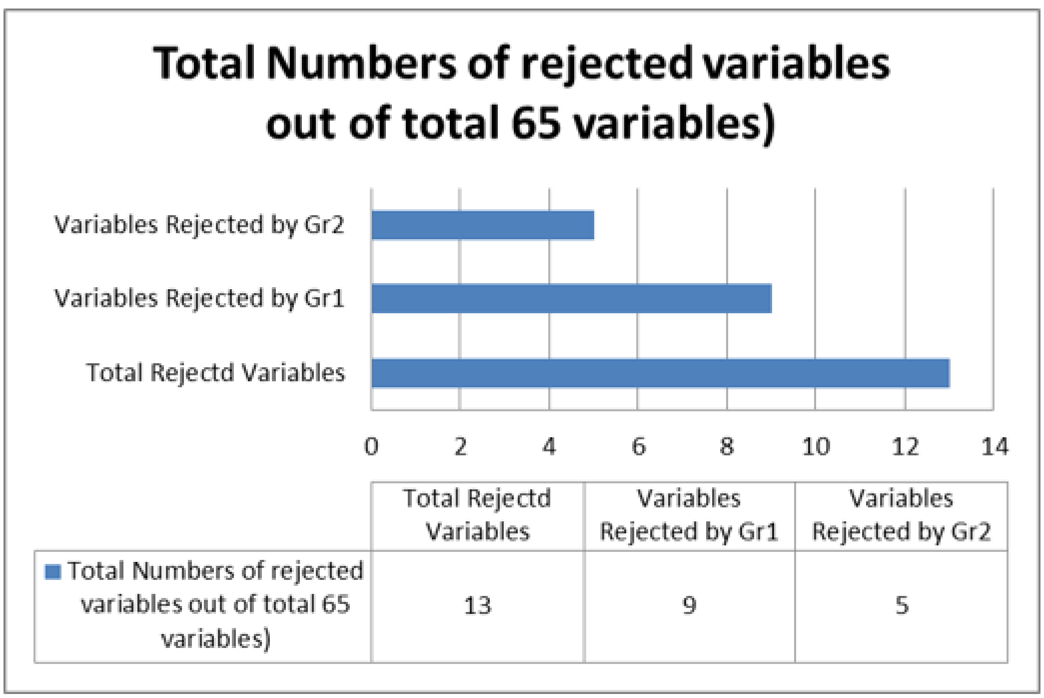


Figure 17

Number of rejected variables

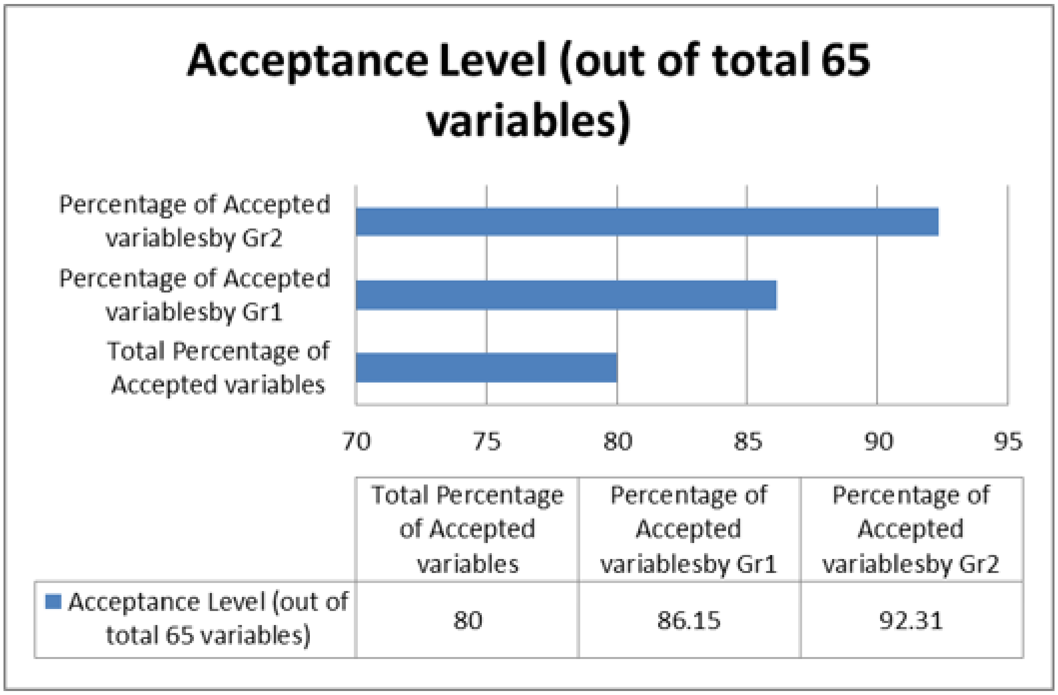


Figure 18

Acceptance level of the CPEF

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Analysisnew.xlsx
- Tablesrevised.docx