The impact of watershed development and management practices on rural livelihoods outcome: A structural equation modeling study in central highlands of Ethiopia

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November 24, 2022

Abstract

The Ethiopian government increasingly recognized the watershed development and management practices as an integral part of rural livelihood development. However, studies associated with the impact of watershed development and management practices on livelihoods are often ambiguous. This study investigated the impact of WDMP on the rural livelihoods outcomes; in terms of income and employment generation, agricultural productivity, and social service and infrastructure. This was a study of cross-sectional design. Structured Equation Modeling (SEM) and Livelihood Approach (LA) were used to identify the impact of WDMP and to assess the status of the livelihood assets, respectively. The study found out that due to the implemented watershed development and management practices, the agricultural productivity and incomes of the community increased, employment opportunities were generated, and social service and infrastructure improved in the study area. However, there is no significant difference between the livelihood status of the treated and untreated watersheds. The study suggests that improving livelihood capital is needed to enhance agricultural productivity, income and employment generation, as well as social service and infrastructure through WDMP.

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Abstract

The Ethiopian government increasingly recognized the watershed development and management practices as an integral part of rural livelihood development. However, studies associated with the impact of watershed development and management practices on livelihoods are often ambiguous. This study investigated the impact of WDMP on the rural livelihoods outcomes; in terms of income and employment generation, agricultural productivity, and social service and infrastructure. This was a study of cross-sectional design. Structured Equation Modeling (SEM) and Livelihood Approach (LA) were used to identify the impact of WDMP and to assess the status of the livelihood assets, respectively. The study found out that due to the implemented watershed development and management practices, the agricultural productivity and incomes of the community increased, employment opportunities were generated, and social service and infrastructure improved in the study area. However, there is no significant difference between the livelihood status of the treated and untreated watersheds. The study suggests *that improving livelihood capital is needed to enhance agricultural productivity, income and employment generation, as well as social service and infrastructure through WDMP.*

Keywords: Watershed development and management; Livelihood capital; Agricultural Productivity; Income and Employment generation; and Social Service and Infrastructure

Introduction

A watershed is an area that drains to a common outlet and supplies water by surface or subsurface flow to a drainage system. A watershed includes both biophysical and socio-economic units including all-natural resources, people, and their socio-economic activities within the confines of the drainage divide which varies in size from thousands of square kilometers to a small area drained by a freshet (Darghouth et al., 2008, Adams et al., 2000).

Watershed development and management is organizing and guiding land, water, and other natural resources used in a watershed to provide goods and services while mitigating the impact on the soil and watershed resources. It involves socio-economic, human-institutional, and biophysical inter-relationships among soil, water, and land use and the connection between upland and downstream areas (Ffolliott et al., 2002, Roesner, 1997, Pande, 2020, Farrington and Lobo, 1997, Singh, 1991).

Watershed development and management activities have a potential role in growth, improvement in income levels, improvement in the production of food and fodder, erosion control and prevention of soil degradation, conservation of soil and water, for improvement and development in the socioeconomic and natural resource base of degraded watershed areas (Singh and Woolhiser, 2002, Singh et al., 2002, Wani et al., 2003). As a result, related programs implemented in developing countries focus on conserving and strengthening the natural resource base, making agriculture and other natural resource-based activities more productive, and supporting rural livelihoods to ease poverty (Kerr, 2002, Organization and Aquaculture, 1999, Rao and weekly, 2000).

Soil and water conservation measures implemented in Ethiopia for a long time, though the history of watershed management initiatives dates back to the 1970s. Since then Ethiopia executed watershed projects throughout the country as a potential engine for combating problems raised by land degradation, promoting agricultural growth, and sustaining food security (Gemi and Semane, 2020, Hurni et al., 2010, Negasa, 2020, Bantider et al., 2019, Desta et al., 2005, Chimdesa, 2016, Lakew et al., 2005, Gebregziabher et al., 2016).

Following the practice, researchers conducted varied studies throughout the country. Amongst, studies about the implication of watershed management practices were the pioneer. For instance, the practices decrease soil loss, increase the vegetative cover and grassland, reduce runoff velocity, enhance water infiltration, enhance soil structure, crop yield, biomass production, groundwater recharge, reduce soil erosion, enhance water availability and quality, diversify household income sources, and improve both household income and savings (Tadesse et al., 2017, Mekuriaw, 2017, Meshesha et al., 2015, Yaebiyo et al., 2015, Assan and Beyene, 2013, Siraw et al., 2018). However, most of them are up to evaluating the watershed management and development practices from the physical structures and adoption of technologies, and their biophysical and environmental contribution without quantifying the overall change in household livelihood capital assets; natural capital, physical capital, human capital, financial capital, and social capital.

Therefore, the primary purpose of the study was to assess the effect of watershed management and development practices on the rural livelihood assets of households in the central highlands of Ethiopia. Specifically, study (a) assesses the livelihood status of the community under study watersheds, (b) measures the relationships between livelihood capital (social, human, natural, physical, and financial capital) and watershed development and management practices; and (c) examine the role of watershed development and management practices on income and employment generation, agricultural productivity, and social service and infrastructure.

Based on observations and literature reviews, the researcher proposed the following hypotheses:

> H_1: Watershed development and management practices (WDMP) are positively related to human capital (HC).
>
> H_2: Watershed development and management practices (WDMP) are positively related to physical capital (PC).
>
> H_3: Watershed development and management practices (WDMP) are positively related to the financial capital (FC).
>
> H_4: Watershed development and management practices (WDMP) are positively related to the natural capital (NC).
>
> H_5: Watershed development and management practices (WDMP) are positively related to social capital (SC).

1.

Methods and Material

(a)

Description of the study area

The study conducted in the *Becho* district was found in the *Oromia* regional state, part of the central highlands of Ethiopia, where watershed development and management activities are being implemented. Specifically, the study was conducted on two selected watersheds in the district (*Shankur and Mende Tufesa*). These watersheds originated in southwest *Oromia* of central Ethiopia at a distance of about 80 km from the capital city, Addis Ababa, and 34 km from the zone capital, *Woliso*. They have a total area of 4358ha, of which *Mende Tufesa* contains about 2210ha, whereas *Shankur* contains the remaining 2148 ha. *Shankur and Mende Tufesa* watersheds respectively exhibited altitude ranges from 2286 to 2773 and 2247–2755 m above sea level. Astronomically, the selected watersheds are between 8°32'25" - 8°36'45" N and 38°7'40" - 38°12'20" E (Tadese, 2020).

The watersheds lie exclusively on the headwaters of the Awash River basin. Different landforms, which include plains, slightly dissected side slopes, and piedmonts, characterize the area and degraded extinct central volcanoes, caldera remnants, and associated forms of high relief (Leenaars et al., 2016). There is one perennial river (*Urago* River) and two seasonal rivers (*Shankur and Tareko* Rivers) in the study watersheds. Riverine and scattered trees and scrub are the predominant vegetation types found there. Over 90% of soils in the watersheds are vertisols, which are locally known as *Tikur Afer.* This form of soil is fertile and preferred for agricultural production, even though it is very difficult to prepare the farm for production relative to other forms of soil (Haileyesus and Mekuriaw, 2021). The major watershed development and management activities carried out in the study watersheds are the construction of soil and stone bund, fanya juu bund, gully rehabilitation with check dam, drainage ditches, cut off drain, grass/shrubs/strip, agroforestry, area closure, compost, legume-cereal crop rotation, and inter-cropping.

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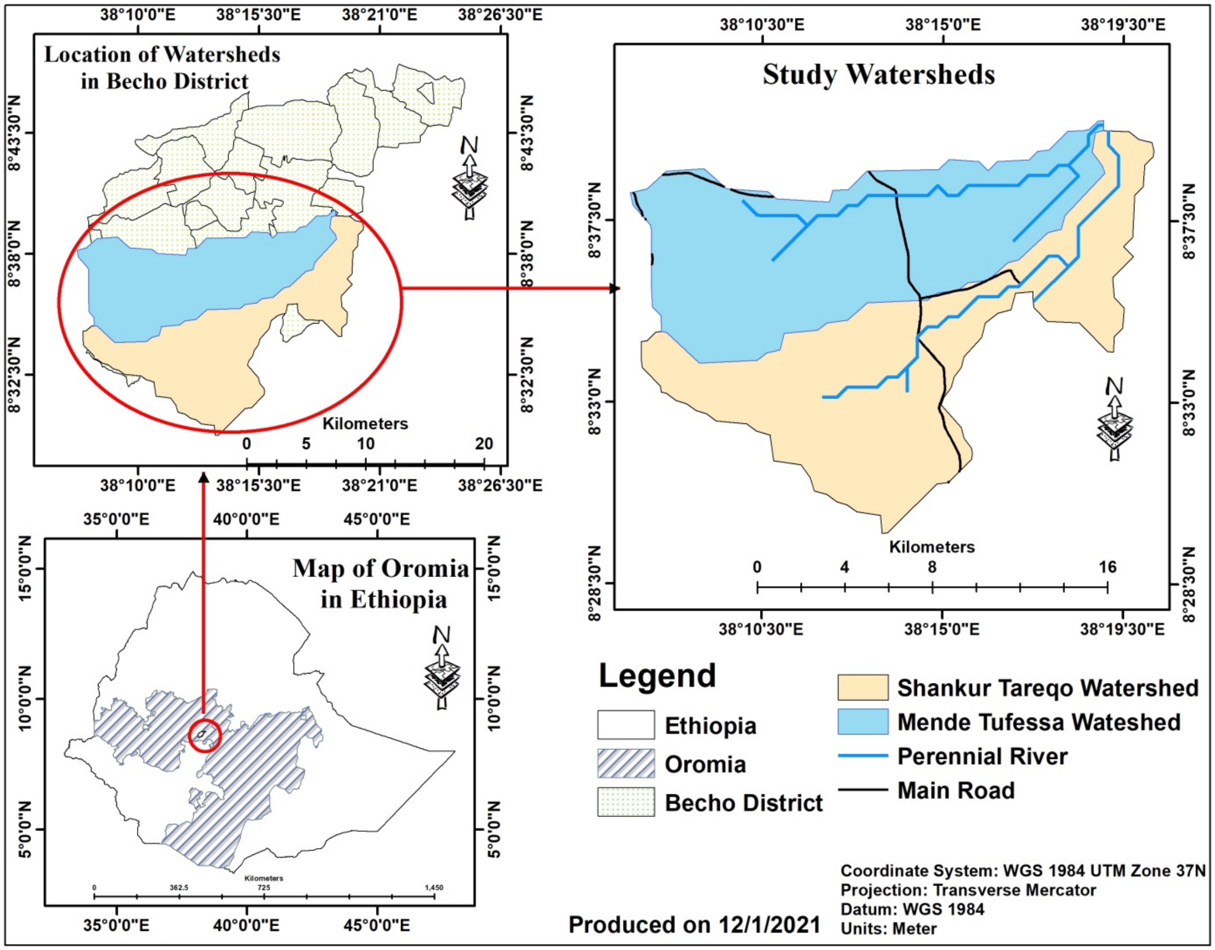

Figure 1: Map of the study area

Methods of data collection and analysis

The primary data collects through in-depth interviews, Focus Group Discussions (FGDs), and household surveys. In-depth interviews were conducted with key informants, including village heads, elders, and government officials. Five FGDs were conducted, three of them accompany based on a single category design (Rabiee, 2004) for village elders and government officials comprising 6 to 8 members each. The researcher administered the other two FGDs with a multiple category design of 8 and 9 mixed participants, respectively. Each group discussion lasted from 2 hours and 50 minutes until saturation reaches. Finally, a cross-sectional survey research design was employed to collect necessary information related to household characteristics and access to the five livelihood capitals (natural, physical, financial, human, and social) using a structured questionnaire survey. Secondary data was collected from different sources, like annual reports, journals, books, and census documents published and unpublished reports of the government.

A multistage sampling technique employs to select a representative sample of the study households. In the first stage, the *Becho* district amongst central highlands of Ethiopia was selected purposely, and then through visual field observation and in consultation with experts of the Agricultural and Natural Resources office of *Becho Woreda*, development agents (DAs), and local people, two watersheds purposively selected. The selected understudy watersheds were picked considering the subjectivity of watershed development and management practices in the area. The *Shankur* watershed (treated watershed or a watershed subjected to different management practices) and *Mende Tufesa* watershed (supposed as a control watershed) are adjacent to one another. Those areas are similar in Agro climate conditions, soil types, and topography of the land. Finally, sampled households from the selected study watersheds select using systematic random sampling techniques. The survey conducts with the household heads of each sample household.

A proportional random sampling technique was applied to fix the sample size in the selected watershed sites. The total number of household heads in the selected sub-watershed or villages was 1636, out of which 801 were from Shankur and 835 were from Mende. The sample size is determined by Kothari (2004) formula, which is described as follows;

$$n = \frac{Z^2 p * q}{e^2}$$

Valid where, n = sample size, Z= the value on the Z score at 95% confidence level =1.96, e = Sampling error at 5%, p= maximum variability of the population at 50%. i.e. (0.5), and q = 1-p = 0.5. The overall sample size of the study was determined as 312 households out of which 49% were from Shankur and 51% were from Mende (Kothari, 2004).

Descriptive and inferential statistics were the main quantitative tools used to analyze the quantitative data. Statistical package for social sciences (SPSS) software version 26 and Microsoft Excel 2016 were used to analyze the quantitative data. Besides, to test the hypothesized structural equation model, AMOS 23.0 was employed and the maximum likelihood estimation was used to examine the proposed hypothetical model. Qualitative data were generated through open-ended questionnaires, interviews, FGDs, field observation, and photographs analyzed qualitatively by triangulating quantitative data.

Framework of Analysis

Since a single asset does not make a living. The study analyzed and understood rural livelihoods in terms of (1) peoples' access to five types of capital assets; (2) how they combine and transform those assets in the building of livelihoods that as far as possible meet their material and their experiential needs; (3) how people can expand their asset bases through engaging with other actors through relationships governed by the logics of the state, market, and associations; and (4) how they can deploy and enhance their capabilities both to make living more meaningful and to change the dominant rules and relationships governing how resources control, distributed and transformed in society. It clearly emphasizes the significance of combining different assets to achieve successful livelihood outcomes (Bebbington, 1999, Ellis, 2000a, Scoones, 2009, Baffoe and Matsuda, 2018).

Watershed development and management practices are viewed as a vehicle to improve the livelihood security of rural people in many parts of the world. The study adopted an analytical framework based on the sustainable livelihood framework model with necessary modifications. The sustainable livelihood perspective provides an opportunity to stand back and explore how watershed development and management affect the livelihoods of the poor, and to see how these impacts can enhance (DfID, 1999, Chambers and Conway, 1992).

The livelihood framework allows one to ''map'' the consequences of specific changes, including changes brought about through external interventions intended to improve people's lives. Various studies have emphasized various aspects of watershed development and management intervention in the watershed areas and their impact on sustainable rural livelihoods. Interventions can aim to strengthen different capital assets depending on the needs of local communities, including food security, agricultural productivity, provision of social services and infrastructures, job creation, technology transfer, savings and credit, and so on (Ellis, 2000a, Ellis, 2000b, Bezemer* et al., 2005, Reddy and Soussan, 2004, Sayer and Campbell, 2004).

The study assessed the impact by modifying the sustainable livelihood framework. The purpose of applying the modified SLF in this study is the crucial factors affecting people's livelihoods, along with the existing typical relationships presented. In the framework, livelihood assets include those capabilities, assets, and activities required for a means of living (Hussein, 2002, Natarajan et al., 2022). There are namely, human, social, natural, physical, and financial capitals that are represented by pentagons shape to show households' differential access to assets (DfID, 1999, Karki and Management, 2021). Livelihood outcome encompasses three latent variables of income and employment generation, agricultural productivity, and social service and infrastructure epitomized by circle shape (Mfunda et al., 2011, Kassegn et al., 2021, Marchang and studies, 2018).

The framework emphasizes the interrelationships between livelihood capital and livelihood outcomes with the intervention of watershed development and management practice. The structural equation model (SEM) is grouped under a category of a combination of factor analysis with structural models, which are regression analysis/ path analysis (Hox and Bechger, 1998). SEM allows for complex relationships between one or more independent variables and one or more dependent variables. SEM allows for ease of interpretation of latent variables and as a model has been implemented and scored good results by diverse studies (Schreiber et al., 2006, Gomez and Stavropoulos, 2021, Le Dang et al., 2014, Villeneuve et al., 2018, Wang et al., 2021, Suárez et al., 2022).

Therefore, the SEM was selected for the framework to assess the relationship between livelihood assets, WDMP, and livelihood outcomes. Each indicator and variable (livelihood assets, livelihood outcomes, and watershed development and management practices) in the conceptual framework is adapted and modified from (Carladous et al., 2019, Watson et al., 2002, Carney, 1998, Scoones, 1998, Ellis, 2000a, Mengistu et al., 2020, Qasim et al., 2019).

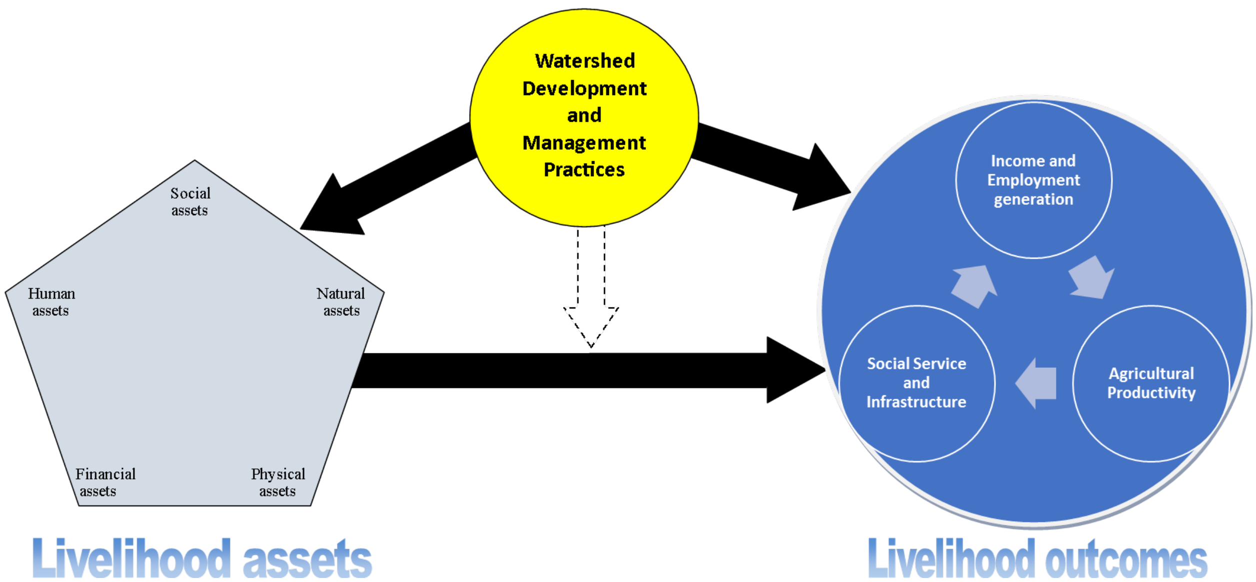

Figure 2: Conceptual framework

Measuring the livelihood status of the community

For the current study, 18 variables select to represent the five livelihood assets (described in the table 1) of selected watersheds. The major reasons for the selection of these variables were based on the works of literature and observational findings depending on the state of livelihood conditions and the role of watershed development and management practices for the watershed communities under study.

The indicators used to measure human assets under this study are represented by four variables i.e. household's head age and years of education completed, the household size, and the number of the labor force in the household (Bingen et al., 2003, Solesbury, 2003, Chambers and Conway, 1992, DfID, 1999). The financial status of households is assessed in terms of several income sources, agricultural and nonagricultural income of household annually, the total size of livestock, and availability of a source of credit (Scoones, 1998, Solesbury, 2003, DfID, 1999).

Social capital is the base for development and stability in all societies (Esfandeh et al., 2021, Xiong et al., 2021). To assess the social assets of the watershed communities, the study analyzed their membership in any social organizations, their social network and harmony, and the presence of NGOs or local institutions (Katz, 2000, Solesbury, 2003, Chambers and Conway, 1992, DfID, 1999, Ninan and Lakshmikanthamma, 2001). The physical asset status of the household is assessed on the components such as the quality of housing structure, types of items the household hold, the convenience of public transportation, and the distance to the nearest market (Rakodi, 1999, Solesbury, 2003, Chambers and Conway, 1992, DfID, 1999). The status of households' natural assets is assessed in elucidations for understanding the factual position of the natural asset in terms of access to agricultural land, area of farmland belonging to the household, and area of high-quality farmland belonging to the household (Solesbury, 2003, Chambers and Conway, 1992, DfID, 1999).

Table 1: Selected indicators and their unit

@ >p(- 4) * >p(- 4) * >p(- 4) * @ Livelihood Capitals & Indicators & Unit of indicators
Human Capital & Household head age & 1=below 20, 2=21-40

3=41-60, 4=above 60
& Household head education level & 1= technical school or higher

2= high school, 3= primary school,

4= no formal education
& Household size & 1=0-4, 2=5-6, 3=>6
& Number of working family labors & 1=0-2, 2=3-5, 3=>6
Financial Capital & Number of income sources &

- Over four income sources = 1,
- There are only three sources of income.
- There are only two sources of income.
- There is only one source of income.

& Agricultural and nonagricultural income annually (birr) & 1= >200,000, 2= 150,000-<=200,000,

3= 100,000-<=50,000, 4= <50,000
& Total size of livestock & 1=>20, 2=10-<=20, 3=5-<=10, 4=<=5
& Availability of the source of credit & 1=yes, 0=no
Natural Capital & Access to agricultural land & 1=yes, 0=no
& Agricultural land size (for crops, grass, trees, etc.) & 1= >10 ha, 2= 5 ha -<=10 ha,

3=1 ha -<=5 ha, 4= <1 ha)
& Fertility of agricultural land & 1=yes, 0=no
Physical Capital & High-quality housing structure (with high quality of wall (*gidegeda*), roof (*tara*), and floor (*wolele*) & 1=yes, 0=no
& Households having a solar panel and mobile phone & 1=yes, 0=no
& What mode of transportation & 1= bus or minibus, 2= motorcycle (*bajaje*) 3=cart (*gari*), 4= walk or on foot
& Distance to the nearest market & 1= >10km, 2= 5km-<=10km,

3=1km-<=5km, 4= <1km
Social Capital & Membership in any social organizations & 1=yes, 0=no
& Having social network and harmony & 1=yes, 0=no
& Presence of NGOs or local institutions & 1=yes, 0=no

After scheming livelihood assets with their relevant indicators, we adopted various scaling and indexing methods to make them comparable and to allow meaningful interpretation. Most of the indicators' scores used in the study have been determined by using rating scale methods. The rating scale method with varying weights was used to determine these variables. The indices derived from the variables in this study were between 0 to 1; higher values showed better livelihood assets. We then depicted these indices in the livelihood asset pentagon, which is a component of the sustainable livelihood framework (Shivakoti and Shrestha, 2005, Qasim et al., 2019).

According to the works of literature reviewed, indicators are determined in terms of different weight ages; with two critical values of 0 and 1 interpreted as poor and good, respectively; with three critical values of 0.33, 0.66, and 1 interpreted as poor, average, and good, respectively; with four critical values 0.25, 0.50, 0.75 and 1 interpreted as poor, average, good and very good respectively (Shivakoti and Shrestha, 2005, Dutta and Guchhait-Barddhaman, 2018, Ibrahim et al., 2017, Liu et al., 2018b, Pelletier et al., 2016, Liu et al., 2018a). After calculations of the weight and calculation of the relevant indices for the concerned variables, we calculated a composite measurement index for each type of capital using an integrated measurement equation as follows;

Where: C= is the criteria score for each asset (0 C 1); n= denotes n^{th} indicators of criteria (n = 1, 2, 3 …n); I= denotes the indicator; and T= denotes the total number of indicator.

Whereas we calculated the total livelihood assets for each watershed as follows;

Where: LA= denotes livelihood assets; HC= refers to human capitals; NC= natural capitals; PC= physical capitals; FC= financial capitals and SC= social capitals.

To illustrate the livelihood capital differences between communities living in two watersheds; the study conducted nonparametric tests of Kruskal-Wallis tests to test for the statistical significance of the results. Kruskal–Wallis tests were performed to examine whether there were significant differences among the household groups. These methods compare the means for several groups' to the association between a quantitative response variable or categorical explanatory variable (Agresti and Finlay, 2009, Mavah et al., 2018, Quandt et al., 2017).

Measuring the relationships and impact of WDMP on livelihood assets

The structured Equation Modeling (SEM) method is used to analyze the data and investigate the causal relationship between latent variables with measurable observed variables. We evaluated and validated the normality tests for data and model fit at each step. Model fit indices presented acceptable values and the final model recognize with high validity. Then, we analyzed and tested the latent and observed variables of the model using AMOS and SPSS statistic software in two exploratory and confirmatory steps. We edited the final models based on the model fit indices. We calculated the regression coefficients and correlation coefficients between latent variables and the main components of the study. Besides, factor loadings of each observed variable, regression weight, and the contribution of each factor to the explanation of the latent components are estimated and presented for the final interpretation.

A two-step procedure for SEM took place. The first step concerns the measurement model validation and aims to discover the validity of the manifest variables with the latent variable. We conducted the goodness-of-fit testing in the first step. The goodness of fit allows the adequacy of the tested SEM to be evaluated. Specifically, the goodness of fit reflects the extent to which the tested SEM fits the current sample under investigation. We have put multiple goodness-of-fit indices forward to assess the goodness of fit of the measurement model since there are no concrete rules about which goodness-of-fit index is best. The second step evaluates the extent to which it supported the hypothesized relationships between the latent variables within the current sample (Anderson and Gerbing, 1988).

There were nine latent variables in the structural equation model (SEM) examined. Specifically, the latent variables of livelihood outcome involve income and employment generation, agricultural productivity, and social service and infrastructure. The latent variable of watershed development and development is its practices. The latent variables of livelihood capital entail natural capital, human capital, physical capital, financial capital, and social capital. Observed indicators measured those latent variables. We selected observed or manifested variables based on the state of livelihood conditions and the role watershed development and management practices play for the watershed communities under study.

The practices of watershed development and management (WDMP) are the first latent variable, which is measured by what types of practices are there in the study watershed. WDMP is presented in terms of eleven manifest variables. The manifest variables include the construction of soil and stone bund, fanya juu bund, gully rehabilitation with check dam, drainage ditches, cut-off drain, grass/shrubs/strip, agroforestry, area closure, compost, legume-cereal crop rotation, and inter-cropping. Livelihood outcome encompasses three latent variables of income and employment generation, agricultural productivity, and social service and infrastructure.

The second latent variable income and employment generation is measured by 7 manifest variables, including increased income, increased employment generation, and increased household expenditure on food consumption, clothing, education, health, and entertainment. Agricultural productivity, which was the third latent variable, manifested through 7 variables; increased water availability, improvement in land use pattern, improved crop yield, cropping pattern, and increased the status of fodder and livestock. The fourth latent variable entitled social service and infrastructure quantified by 6 manifest variables: the presence of NGOs and local institutions, increment of the social relationship, improved access to transportation, health and education, and better housing conditions of the household.

Table 2: Watershed development and management practices and their manifested variables

Latent variables	Manifest variable	
Watershed development and management practices (WDMP)	WDMP1	Construction of soil and s
	WDMP2	Fanya juu bund
	WDMP3	Gully rehabilitation with
	WDMP4	Drainage ditches
	WDMP5	Cut off drain
	WDMP6	Grass/shrubs/strip
	WDMP7	Agroforestry
	WDMP8	Area closure
	WDMP9	Compost
	WDMP10	Legume-cereal crop rotati
	WDMP11	Inter-cropping

Table 3: Selected latent and manifest variables

Latent variables	Manifest variable	
Income and Employment generation (INC-EMP)	INCEMP1	My household use hired labor besides

Latent variables	Manifest variable	
	INCEMP2	My household annual income has incr
	INCEMP3	It has introduced new employment op
	INCEMP4	The wages of daily labor have increase
	INCEMP5	The household expenditure on food co
	INCEMP6	access to finance has increased
	INCEMP7	It has increased saving
Agricultural productivity (AGRIPROD)	ARGIPROD1	The water availability has increased
	ARGIPROD2	It improved the moisture level of my a
	ARGIPROD3	The quality of agricultural land has in
	ARGIPROD4	There is a visible change in the croppi
	ARGIPROD5	Agricultural yield has increased
	ARGIPROD6	Increase in livestock
	ARGIPROD7	Increase in fodder availability
Social service and Infrastructure (SS-INFR)	SSINFR1	It has increased my social network and
	SSINFR2	I believe it has improved the number o
	SSINFR3	It has improved the means of transpor
	SSINFR4	It has improved the access related to h
	SSINFR5	It has improved the access related to e
	SSINFR6	It has improved the housing and other

The latent variables of livelihood assets involved natural capital, human capital, physical capital, financial capital, and social capital (described in table 1). We measured the relationships of each latent variable by five-point Likcert scales that ranged from 1 (strongly disagree) to 5 (strongly agree).

The SEM model and Path analysis

The livelihood asset parameters (social, human, natural, physical, and financial assets) were investigated through watershed development and management practices. We would see the impact through the livelihood outcomes in increment in income and employment generation, agricultural productivity, and social service and infrastructure; other outcomes being beyond the scope of the study. To verify which livelihood asset positively impact which livelihood outcome through WDMP, need to examine the relationship between WDMP and all five livelihood assets.

The hypothesized structural equation model (SEM) is based on the selected variables and the hypothesized relationships among latent variables presented in Figure 3. The relations among the variables based on the model seen in the Figure below are examined using path analysis. We chose this technique because it simultaneously tests causal processes based on an underlying theory or model. All paths are included in creating just-identified models.

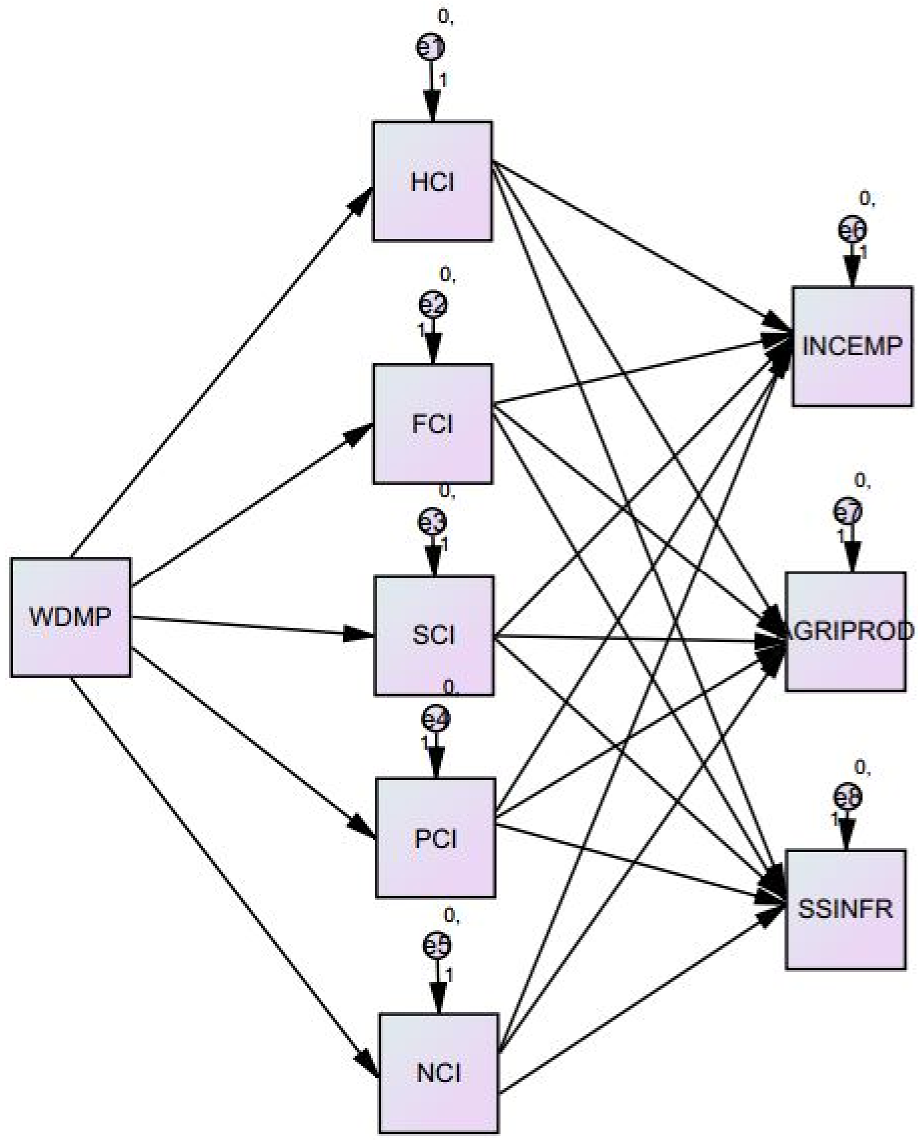

Figure 3: Hypothesized structure equation model (SEM)

Measurement of SEM model fit

We employed AMOS 23.0 to test the hypothesized structural equation model and the maximum likelihood estimation to examine the proposed hypothetical model. Multiple goodness-of-fit indices revealed that the hypothesized structural equation model did not adequately fit the data. In this study, the process for improving model fit includes two steps. We deleted the variables whose measurement error variances are negative in the first step (Bank et al., 1990). However, the result in Figure 4 displayed as the error variances of each measurement was positive. As a result, it subjected none of them to delete.

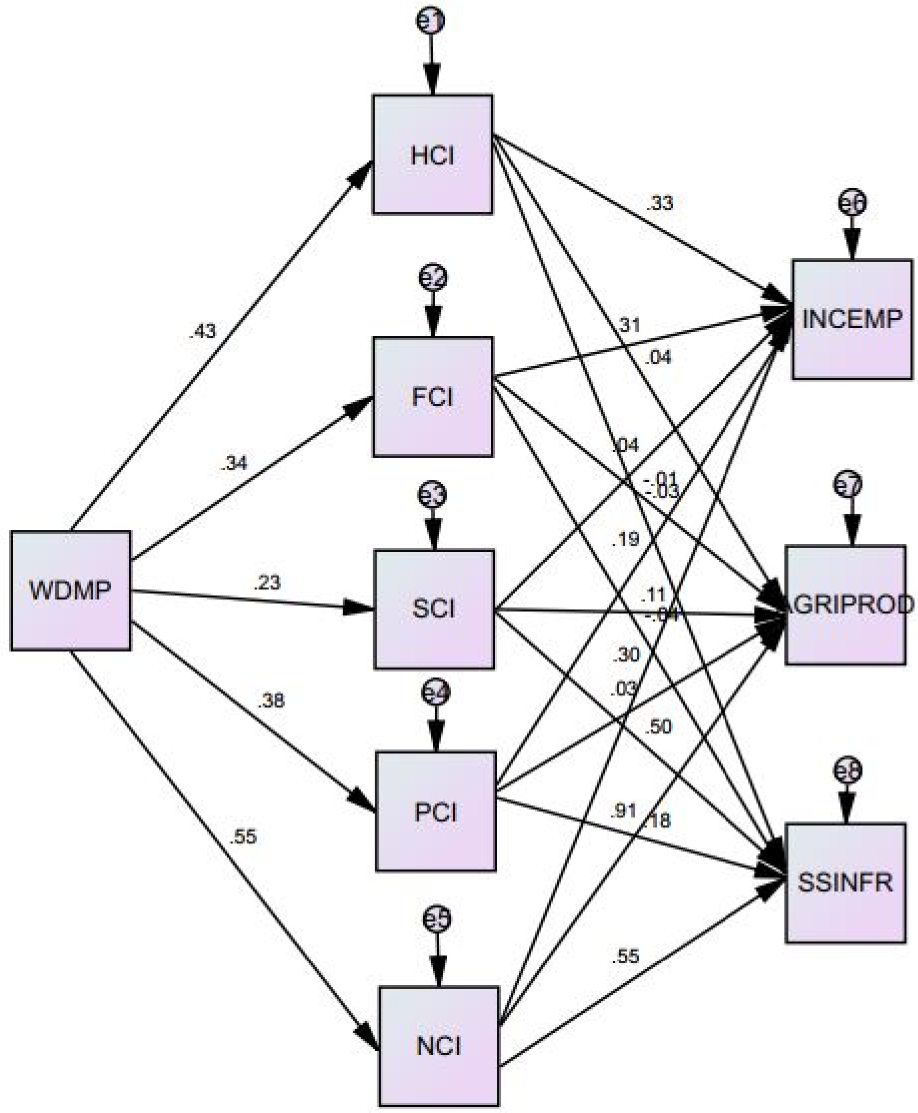

Figure 4: Second Drafted SEM

Then we deleted the paths whose P values were higher than 0.1 and the revised SEM was presented in Figure 5. We resulted in a model fit to the data and presented it in the table 4. Before processing to estimation, the study checked the fitness of the proposed model through Absolute Model Fit, Incremental Model Fit, and Parsimonious Model Fit using chi-square value and probability value, Root Mean Square Error of Approximation (RMSEA), and Goodness of

Fit Index (GFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), and Chi-Square/df. Amos reached a local minimum regarding the model, which showed that the appropriate distributional assumptions were met and the specified model was correct.

Table 4: Model fit indices for structural model

Measurement of the goodness of model fit	Scored Value	Criteria Value	
Absolute Model fit	Chi-square		<0.05
	Root Mean Square Error of Approximation (RMSEA)		<0.08
	The goodness of Fit Index (GFI)		>0.9
Incremental Model fit	Comparative Fit Index (CFI)		>0.9
	Normed Fit Index (NFI)		>0.9
Parsimonious Model fit	Chi-Square/df	**3.624**	**<5.0**

We tested the reliability of the manifest variables with the latent variable. Cronbach's was used to check the reliability of the manifest variable and resulted in a defining part of the latent variable as Cronbach's value was greater than 0.675 in the test. Therefore the manifest variables with the latent variable have high internal consistency. The study also measure the amount of variance Average variance extracted (AVE) and values were above 0.576 in the test. Therefore the manifest variables with the latent variable had high discriminant validity. The correlation matrix is presented in Table 5. Values in corresponding rows and columns are the construct correlations. The construct correlations of that latent variable with other latent variables exhibited high validity in the final SEM and supported the final model figured below in figure 5.

Table 5: Implied (for all variables) Correlations

	WDMP	NCI	PCI	SCI	FCI	HCI	SSINFR	AGRIPROD	INCEMP
WDMP	1.000								
NCI	.553	1.000							
PCI	.378	.209	1.000						
SCI	.232	.128	.088	1.000					

	WDMP	NCI	PCI	SCI	FCI	HCI	SSINFR	AGRIPROD	INCEMP
FCI	.336	.186	.127	.078	1.000				
HCI	.429	.237	.162	.099	.144	1.000			
SSINFR	.470	.636	.305	.579	.158	.202	1.000		
AGRIPROD	.539	.937	.204	.251	.181	.232	.662	1.000	
INCEMP	.492	.488	.358	.114	.442	.478	.374	.464	1.000

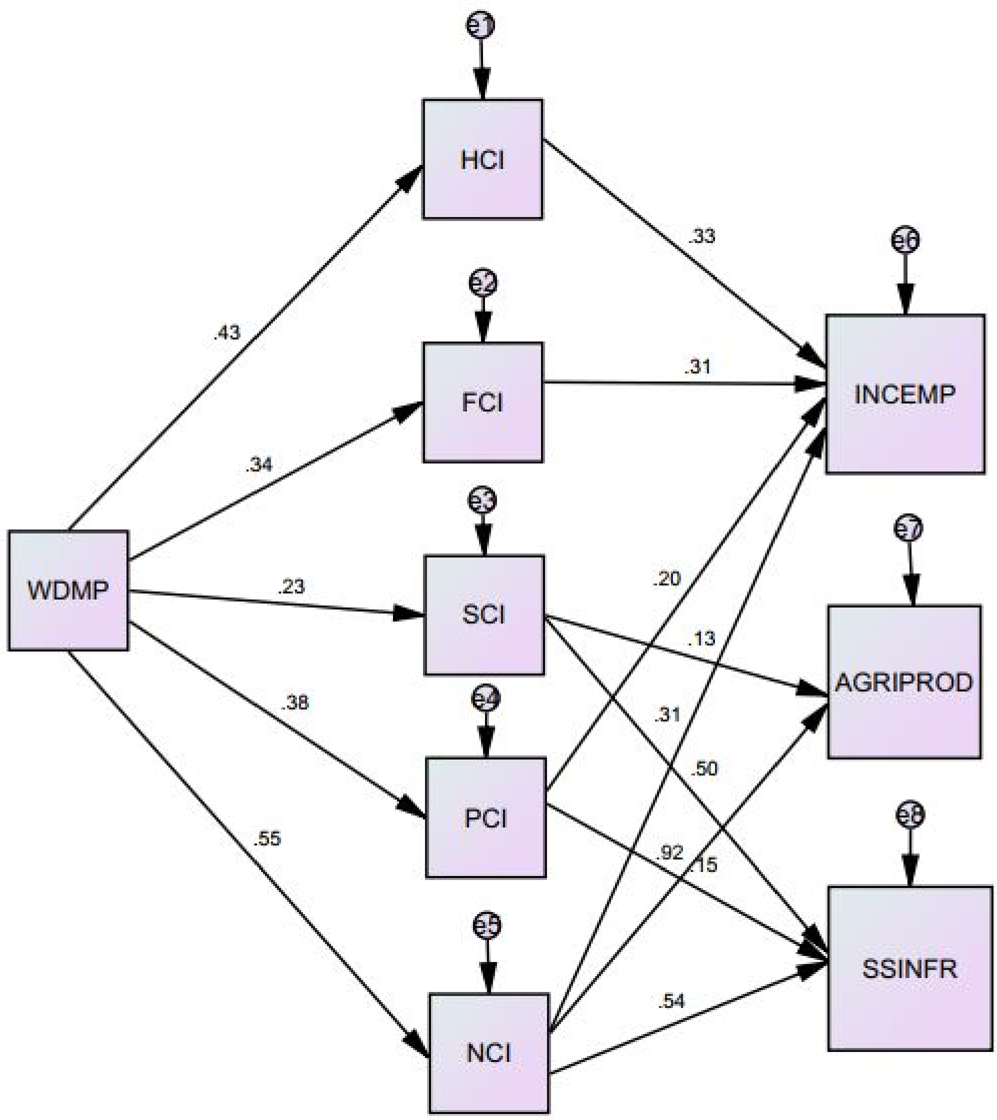

Figure 5: Final structural equation model

Figure 5 shows the outcomes of the final structural equation model (SEM) with standardized parameters. Table 6 presented the unstandardized and standardized estimated parameters.

Table 6: Standardized and unstandardized regression weights

Path	Understand. Estimate	Stand. Estimate	S.E.	C.R.	P	Label		
HCI	<---	WDMP	.315	.429	.038		***	par_1
FCI	<---	WDMP	.300	.336	.048		***	par_2
SCI	<---	WDMP	.068	.232	.016		***	par_3
PCI	<---	WDMP	.237	.378	.033		***	par_4
NCI	<---	WDMP	.250	.553	.021		***	par_5
INCEMP	<---	HCI	.467	.328	.105		***	par_6
AGRIPROD	<---	SCI	.448	.114	.092		***	par_7
SSINFR	<---	SCI		.497	.128		***	par_8
INCEMP	<---	PCI	.319	.191	.096		***	par_9
SSINFR	<---	PCI	.265	.177	.069		***	par_10
INCEMP	<---	NCI	.699	.303	.121		***	par_11
AGRIPROD	<---	NCI		.907	.062		***	par_12
SSINFR	<---	NCI		.553	.087		***	par_13
INCEMP	<---	FCI	.361	.309	.083		***	par_14
AGRIPROD	<---	HCI	.061	.039	.054		.258	par_15
SSINFR	<---	HCI	-.034	-.027	.076	-.451	.652	par_16
AGRIPROD	<---	FCI	-.009	-.007	.043	-.218	.828	par_17
SSINFR	<---	FCI	-.046	-.044	.060	-.774	.439	par_18
INCEMP	<---	SCI	.125	.035	.178	.701	.483	par_19
AGRIPROD	<---	PCI	.063	.034	.049		.202	par_20

According to the result shown in the table 6, there is no relationship between HCI and AGRIPROD, HCI and SSINFR, FCI and AGRIPROD, FCI and SSINFR, SCI and INCEMP, and PCI and AGRIPROD respectively while other relationships had a statistically significant and positive relationship with one another. There were statistically significant negative relationships between HCI and SSINFR, FCI and AGRIPROD, and FCI and SSINFR. Therefore, statistically insignificant relationships were rejected or not included in the final SEM developed.

1.

Results and Discussion

(a)

Livelihood status of the community; comparative analysis

The status of the livelihood assets under-sampled watersheds is discussed in the five capitals of livelihood and the concept of watershed development and management practices. We comparatively analyzed those five capital statuses of the livelihood assets with *Shankur Tereqo* watershed and *Mende Tufesa* watershed (supposed as a control watershed) units.

Table 7: Status of livelihood assets of *Shankur Tereqo* watershed and *Mende Tufesa* watershed

Capitals	Indicators	Shankur Tereqo Watershed	Mende Tufesa Watershed	
		Indicators Weight	Capital Index	Indicators We
Human Capital	HC1	0.83	0.513	0.81
	HC2	0.34		0.35
	HC3	0.49		0.48
	HC4	0.39		0.37
Financial Capital	FC1	0.37	0.343	0.22
	FC2	0.32		0.17
	FC3	0.41		0.20
	FC4	0.12		0.08
Social Capital	SC1	0.95	0.711	0.95
	SC2	0.95		0.97
	SC3	0.94		0.96
Physical Capital	PC1	0.12	0.348	0.07
	PC2	0.71		0.68
	PC3	0.30		0.29
	PC4	0.27		0.27
Natural Capital	NC1	0.98	0.573	0.75
	NC2	0.39		0.27
	NC3	0.84		0.77
Total Livelihood Index	0.497	0.454		

Status of human capital

Human asset entails a combination of abilities that endow households or individuals with earning livelihoods accomplishment. Based on this study, the percent value of mean scores on account of indicators used showed a slight increase in the Shankur Tereqo watershed (0.513) as compared to the Mende Tufesa watershed (0.508). According to a livelihood index ranging from 0 to 0.33, interpreted as poor; the one with 0.34–0.66 as average and 0.67–1 as good. The human capital index of the study area lies within a range of 0.34–0.66; as a result, we can conclude that the household within the watershed had an average human capital and ranked second amongst livelihood capitals studied in the highest index. Households living in both watersheds belonged to an average category of the human asset improvement scale.

The discussion with key informants revealed that the migration of youths from rural areas was widespread in the surveyed areas. The study investigated households' human capital as an essential component of the livelihood generation; however, youths considered to be the backbone of the household in the agriculture arena are not engaged in labor. Migrating is an option for many youths. During focus group discussion, noted that youths of the households flee to urban or to the better nearest city for different reasons. Amongst suggested reasons, the following were pioneers; looking for a job, getting married to an urban dweller for better education, and considering living in a city as a dream life.

Status of financial capital

The financial capital of the household denotes the financial resources that individuals used towards achieving livelihood objectives (Ibrahim et al., 2018). The status of financial capital showed one step ahead in the Shankur Tereqo watershed (0.343) as compared to the Mende Tufesa watershed (0.210). The financial capital status of Shankur Tereqo watershed according to the range the scored index value was within 0.34–0.66 range analyzed as average, while the controlled watershed was in 0 to 0.33 ranges interpreted as poor. The Shankur Tereqo watershed households belong to average financial capital than the control one. Comparatively, the household within the Mende Tufesa watershed lives with poor financial capital and ranked fifth or the lowest index value amongst livelihood capitals studied.

Status of social capital

The social capital index of the study area ranked first amongst other livelihood capitals; as a result, we can conclude that the household within the watershed had the highest or good social capital. The percent value of mean scores on account of indicators used showed a slight increase in the Mende Tufesa watershed (0.719) as compared to the Shankur Tereqo watershed (0.711); though the difference is not significant. According to a livelihood index, this result showed up in a good range of 0.67–1. Almost 95% of the members of the watershed community were a member of the local finance group (*Equb*), religious group or spiritual group (*Mahiber*), mutual support association (*Edir*), and self-help labor (*Debo/Jige*). There were also households, but few actively take part in the political arena, being political party members of the ruling government (*Cabinee*) and local peacekeepers (*Mlisha*).

Status of physical assets

We assessed the status of a physical asset in the components of quality of housing structure, types of items the household hold, convenience of public transportation, and the distance to the nearest market. The value of financial capital displayed a slight increase in the Shankur Tereqo watershed (0.348) as compared to the Mende Tufesa watershed (0.328). According to the range of scored index, the control watershed is valued within 0 to 0.33 ranges, which is interpreted as poor; while the scored a value of another watershed slightly joined an average livelihood index. Even though the aggregated mean of physical capital calculated ranges under 0.34. We can conclude that both watersheds were under poor physical capital and ranked fourth or the second-lowest index value amongst livelihood capitals studied.

They traditionally built houses with low-quality walls (*gidegeda*), roofs (*tara*), and floors (*wolele*). I saw only a few stone buildings during the field research. The absence of financial means to invest, deficiency of credit, and lack of infrastructures; such as roads most times, led them to live in a traditional insecure houses. During the focus group discussions and field research, I noted that access to the study area was almost only on unsealed dirt roads. Since most villages are in a hilly or even mountainous landscape, dirt roads often passed difficult conditions at transforming altitudes, as well as land that is subject to regular flooding. The lack of transport infrastructure had a major constraint faced by the households living in the area, particularly with market activities throughout the year (livestock, shopping, going to the hospital, social engagement) and especially during and after the time of harvest (cereals). Though the surveyed watersheds are near urban centers, as paved roads are missing, they isolated the communities.

The key informants reported a lack of basic infrastructure as one of the major constraints in their areas. The electricity supply was none. Some households considered middle income or rich got electric power and light from solar panels. Unlike the use of radio and TV, using mobile communications within the sampled watershed is common; most household heads and youths have occasional access within their household. None of the household understudies own a vehicle, so reaching the urban areas, where hospitals, secondary schools, markets, and wage labor opportunities lay only by walking or with the use of a donkey or mule in most of the villages also in dry seasons. They also reported a lack of basic health care in the village among the major constraints in rural life. Clinics are difficult to reach because of poor roads. They also reported a lack of water in the houses during FGD as a great limitation in their everyday life in their watershed districts.

Status of Natural Capital

We have made elucidations for understanding the factual position of the natural capital status of the households in terms of access to agricultural land, area of farmland belonging to the household, and area of high-quality farmland belonging to the household. The value of natural capital showed a slight increase in the Shankur Tereqo watershed (0.573) as compared to the Mende Tufesa watershed (0.509). According to the range, the scored index value of both watersheds lay within the 0.34 to 0.66 ranges, which are interpreted as average. We can conclude as almost all household heads in the watershed run agriculture with average natural capital. During field research, I observed large parts of the landscape around the villages as highly degraded by flood erosion, as natural resources such as trees and shrubs were unsustainably collected from the wild; deforestation was observed to be a major issue.

Comparison of livelihood assets within the study area

The pentagon showed comprehend and comparative livelihood status of each sample's watershed and described the status of livelihood assets as a realm. A total livelihood index ranged from 0.34–to 0.66 labeled as the watershed under study were average in livelihood assets. The overall livelihood status of the Shankur Tereqo watershed (0.497) is slightly higher than the control watershed (0.454) even though ranged at the same level in terms of livelihood asset index.

Table 8: Overall Livelihood Asset index

Livelihood asset	Watershed	
	Shankur Tereqo	Mende Tufesa
Human Capital Index	0.513	0.508
Financial Capital Index	0.343	0.210
Social Capital Index	0.711	0.719
Physical Capital Index	0.348	0.328
Natural Capital Index	0.573	0.509
Total Livelihood Index	0.497	0.454

[CHART]

Figure 6: Total livelihood index

The Kruskal-Wallis test calculated the statistical results of 18 variables related to five types of livelihood capital, and the results illustrate that the livelihood situation is the same leveled "Average". However, the changes in different capital are associated with different results and features. Financial capital and physical capital the value in the Mende Tufesa watershed is below 0.33, which is interpreted as poor compared to the Shankur Tereqo watershed. Although there is an increase in some variance; human capital and natural capital values still belong to the interval "0.33–0.66", which shows that the status of human capital and natural capital in livelihood assets are not very significant, representing an "Average" change. Social capital: the value of social capital showed a significant change compared to the other capitals, and the values for both watersheds belong to the "Good" category. The Kruskal-Wallis test resulted as there is no significant difference between the livelihood status of the Mende Tufesa and Shankur Tereqo watershed households.

The relationship between WDMP and livelihood assets

Table 9 displays, that watershed development and management practices (WDMP) had statistically significant positive relationships with all livelihood assets. WDMP had the highest correlation or significant positive relationship with natural capital compared to livelihood capital, while it had the lowest correlation with social capital, yet a statistically significant positive relationship existed.

Table 9: the relationship between WDMP and livelihood assets

Path	Stand. Estimate	S.E.	C.R.	P	Label	
HCI	<---	WDMP	.429	.038	***	par_1
FCI	<---	WDMP	.336	.048	***	par_2
SCI	<---	WDMP	.232	.016	***	par_3
PCI	<---	WDMP	.378	.033	***	par_4
NCI	<---	WDMP	.553	.021	***	par_5

Results yielded by this technique show that WDMP has a positive relationship with all livelihood assets; the strength of the relation is quite strong. Moreover this relation is significant i.e. $P=0.000(P < 0.05)$. These conclusions lead to acceptance of the alternative hypothesis and rejection of the null hypothesis.

H_1*:* Watershed development and management practices (WDMP) are positively related to human capital (HC).

Analysis in table 9 showed that Watershed development and management practices (WDMP) had a statistically significant and positive relationship with human capital (HC) on standard estimation or path coefficient of 0.43. It means when WDMP goes up by 1 standard deviation, HC goes up by 0.429 standard deviations. As the p-value is less than 0.05 therefore we accept the alternative hypothesis and reject the null hypothesis.

H_2*:* Watershed development and management practices (WDMP) are positively related to physical capital (PC).

WDMP had also a statistically significant and positive relationship with the physical capital (PC) of the watershed community with a path coefficient of 0.378, interpreted as when WDMP goes up by 1 standard deviation, PC goes up by 0.378 standard deviations. Based on these results we will again accept the alternative hypothesis and reject the null hypothesis.

H_3*:* Watershed development and management practices (WDMP) are positively related to the financial capital (FC).

WDMP is positively related to the financial capital with a standard estimation or path coefficient of 0.336, meaning when WDMP goes up by 1 standard deviation;

the financial capital of the household goes up by 0.336 standard deviations. Based on these results, we accept the alternative hypothesis and reject the null hypothesis.

*H_4: * Watershed development and management practices (WDMP) are positively related to the natural capital (NC).

According to the path analysis, the natural capital of the watershed had positively correlated with WDMP on the path coefficient of 0.553 meaning as of WDMP goes up by 1 standard deviation, NC of the rural household of the community goes up by 0.553 standard deviations. As the p-value is less than 0.05 therefore we accept the alternative hypothesis and reject the null hypothesis.

*H_5: * Watershed development and management practices (WDMP) are positively related to social capital (SC).

The fifth hypothesis resulted, that watershed development and management practices had a statistically significant positive relationship with the social capital of the households by a path coefficient of 0.232, which means an increase of WDMP by 1 standard deviation; SC goes up by 0.232 standard deviations. Since the p-value is less than 0.05 therefore we accept the alternative hypothesis and reject the null hypothesis.

The impact of WDMP on livelihood outcomes

Table 10 showed the path coefficients for watershed development and management practices (WDMP) and its standardized direct and indirect effects on the five livelihood capitals and income and employment generation, agricultural productivity, and social services and infrastructure.

Table 10: Path coefficients for watershed development and management practices (WDMP)

Variable	Standardized Direct Effects	Standardized Indirect Effects	Standardized Total Effects
NCI	.553	-	.553
PCI	.378	-	.378
SCI	.232	-	.232
FCI	.336	-	.336
HCI	.429	-	.429
SSINFR	-	.461	.461
AGRIPROD	-	.555	.555
INCEMP	-	.493	.493

All Path Coefficient is significant at 0.00 levels (2-tailed).

The impact of WDMP on Income and Employment Generation

The standardized direct (unmediated) effect of WDMP on INCEMP is 0.000. But the standardized indirect (mediated) effect of WDMP on INCEMP is 0.493. That is, because of the indirect (mediated) effect of WDMP on INCEMP, when WDMP goes up by 1 standard deviation, INCEMP goes up by 0.493 standard deviations. This is besides any direct (unmediated) effect that WDMP may have on INCEMP.

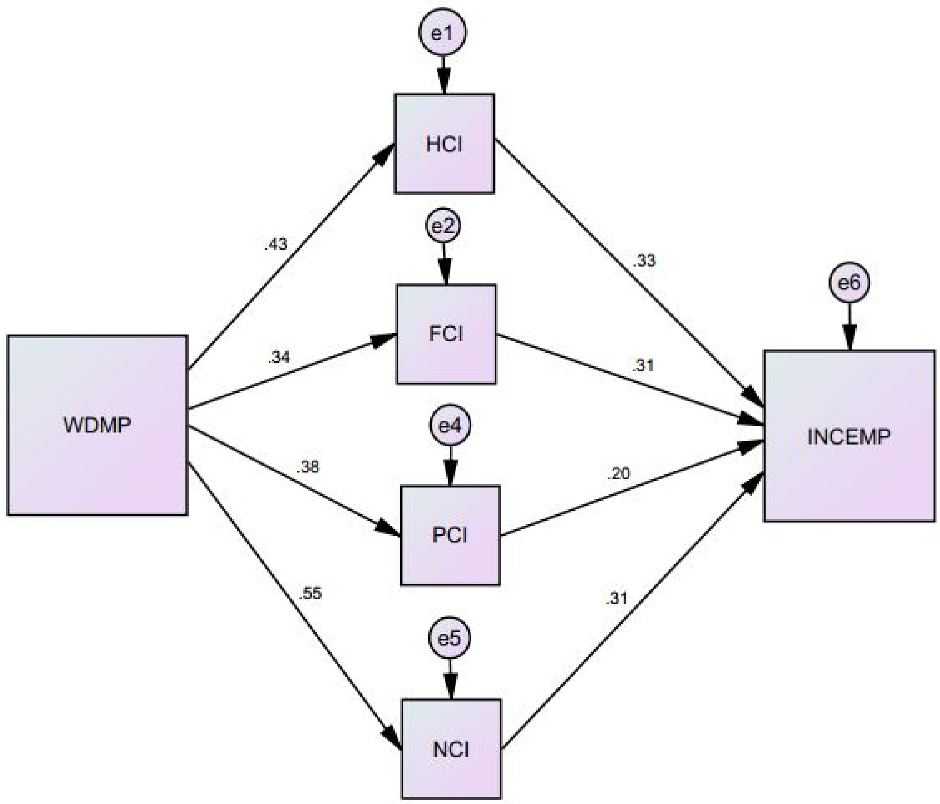

Figure 7: Standardized effect of WDMP on INCEMP

The results of SEM show that the watershed development and management practices as a mediated factor had a significant positive relationship with income and employment generation through livelihood capitals of HC, PC, NC, FC, and SC. WDMP has impacted the household's income-generating and employment generation potentials by impacting households' livelihood assets especially human, financial, physical, and natural capital. The standardized direct (unmediated) effect of social capital on INCEMP has been estimated at 0.035 it was not significantly different from zero (p=.483).

The standardized direct (unmediated) effect of HCI on INCEMP is 0.328. Because of the direct (unmediated) effect of HCI on INCEMP, when HCI goes up by 1 standard deviation, INCEMP goes up by 0.328 standard deviations. This is besides any indirect (mediated) effect that HC may have on INCEMP. The standardized direct (unmediated) effect of PCI on INCEMP is 0.191. That is, because of the direct (unmediated) effect of PCI on INCEMP, when PCI goes up by 1 standard deviation, INCEMP goes up by 0.191 standard deviations. This is besides any indirect (mediated) effect that PCI may have on INCEMP. The standardized direct (unmediated) effect of NCI and FCI on INCEMP is 0.303and 0.309 respectively. Because of the direct (unmediated) effect of NCI and FCI on INCEMP, when NCI and FCI go up by 1 standard deviation, INCEMP goes up by 0.303 and 0.309 standard deviations. This is besides any indirect (mediated) effect that NCI and FCI may have on INCEMP.

Watershed development and management practices were a means for the households in generating more income and creating employment opportunities in the study area. WDMP can generate employment amongst the community and played a great role in household income-generating activities by impacting households' livelihood assets especially human, financial, physical, and natural capital. According to FGDs, most of the communities in the study areas are dependent completely on agriculture for their livelihood no other way to create job opportunities. Even if there are some finger-counted small businesses in the community; like mini-market and mini groceries, it is hard to conclude that they are created or established due to the direct impact of watershed development and management practices.

The impact of WDMP on Agricultural Productivity

The standardized indirect (mediated) effect of WDMP on AGRIPROD is 0.555. Because of the indirect (mediated) effect of WDMP on AGRIPROD, when WDMP goes up by 1 standard deviation, AGRIPROD goes up by 0.555 standard deviations. This is besides any direct (unmediated) effect that WDMP may have on AGRIPROD. The results of SEM showed that the watershed development and management practices as a mediated factor had a significant positive relationship with agricultural productivity through the livelihood capitals of natural and social capital. WDMP has impacted the households' agricultural productivity by impacting households' livelihood assets, especially natural and social capital. PC and FC directly impacted agriculture by 0.034 and 0.007 standard deviations, they were not statistically significant with the p-value of (0.258 and 0.202) respectively. The standardized direct (unmediated) effect of FCI on AGRIPROD was negative (-.007) meaning when FCI goes up by 1 standard deviation, AGRIPROD goes down by 0.007 standard deviations. This is besides any indirect (mediated) effect that FCI may have on AGRIPROD with the p-value of 0.828.

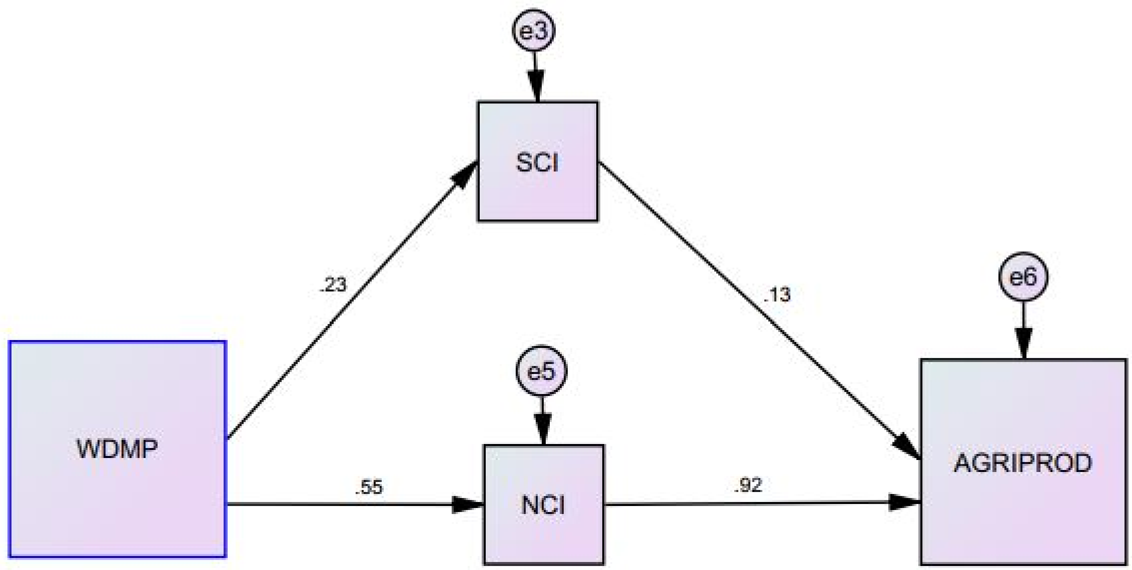

Figure 8: Standardized effect of WDMP on AGRIPROD

The standardized direct (unmediated) effect of NCI on AGRIPROD was 0.907. That is, because of the direct (unmediated) effect of NCI on AGRIPROD, when NCI goes up by 1 standard deviation, AGRIPROD goes up by 0.907 standard deviations. This is besides any indirect (mediated) effect that NCI may have on AGRIPROD. The impact of WDMP on natural capital indirectly impacted the agricultural productivity of the household highly. It has also impacted agriculture productivity through social capital, when SCI goes up by 1 standard deviation; AGRIPROD goes up by 0.114 standard deviations. This is besides any indirect (mediated) effect that SCI may have on AGRIPROD.

The qualitative data reflected that in the study area it was noticed an increase in cropping area for double crops, a change in single to double-crop/mixed cropping, increase in crop production due to improvement in land and water conservation practices. In the study areas, WDMP has led to an increase in yields and cropping intensity due for various reasons. These reasons include an increase in residual moisture content due to the construction of soil and stone bund and cut-off drain, and applying inter-cropping and compost.

The impact of WDMP on Social Services and Infrastructure

The results of SEM specified that the standardized indirect (mediated) effect of WDMP on SSINFR is 0.461. That is, due to the indirect (mediated) effect of WDMP on SSINFR, when WDMP goes up by 1 standard deviation, SSINFR goes up by 0.461 standard deviations. This is in addition to any direct (unmediated) effect that WDMP may have on SSINFR. As a mediated factor, WDMP had a significant positive relationship with social services and infrastructure through the livelihood capitals of natural, social, and physical capital. WDMP has impacted the households' social services and infrastructure by impacting households' livelihood assets, especially on natural capital next to social capital.

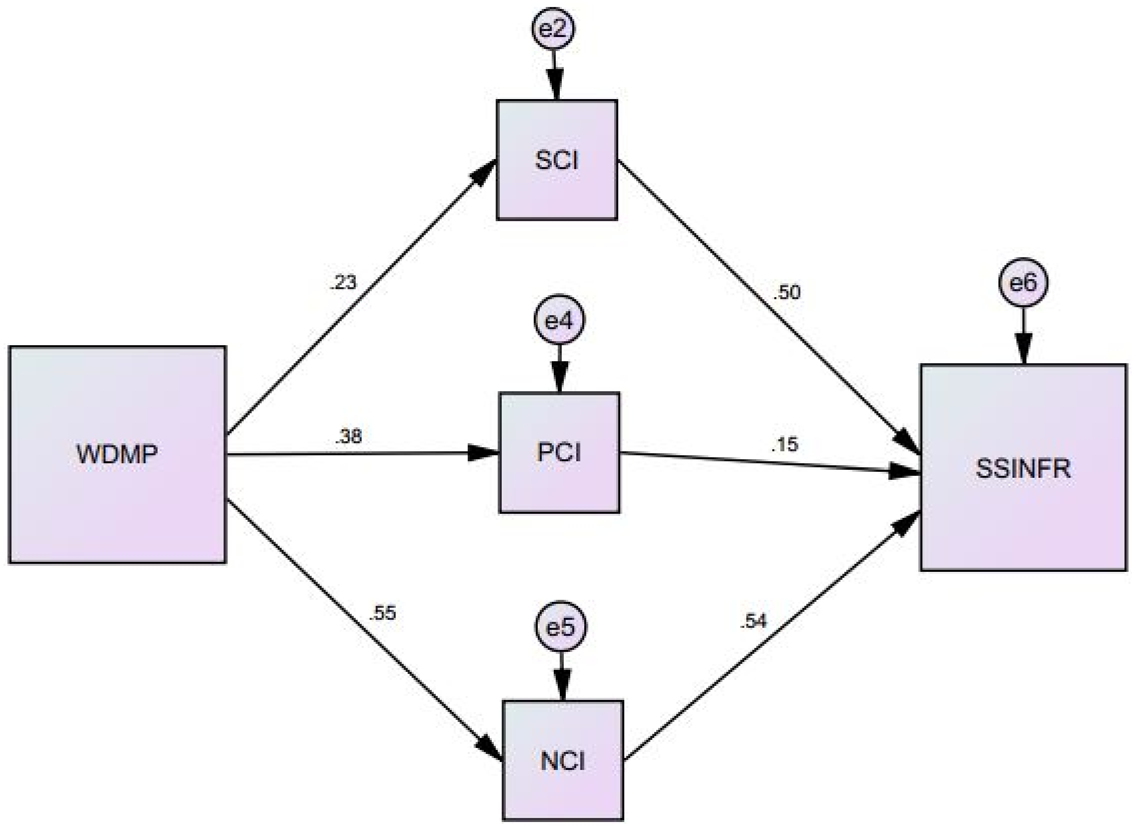

Figure 9: Standardized effect of WDMP on SSINFR

The standardized direct (unmediated) effect of NCI on SSINFR is 0.553. Because of the direct (unmediated) effect of NCI on SSINFR, when NCI goes up by 1 standard deviation, SSINFR goes up by 0.553 standard deviations. This is besides any indirect (mediated) effect that NCI may have on SSINFR. The standardized direct (unmediated) effect of SCI on SSINFR is 0.497. Because of the direct (unmediated) effect of SCI on SSINFR, when SCI goes up by 1 standard deviation, SSINFR goes up by 0.497 standard deviations. This is besides any indirect (mediated) effect that SCI may have on SSINFR. The standardized direct (unmediated) effect of PCI on SSINFR is 0.177. Because of the direct (unmediated) effect of PCI on SSINFR, when PCI goes up by 1 standard deviation, SSINFR goes up by 0.177 standard deviations.

HC and FC directly impacted social services and infrastructure negatively by (-.027 and -.044) and they were not statistically significant with the p-value of (0.652 and 0.439) respectively. We can interpret it as when HC and FC go up by 1 standard deviation, SSINFR goes down by -0.027 and -0.044 standard deviations. This is besides any indirect (mediated) effect that HC and FC may have on SSINFR.

Conclusion

The study found out the overall livelihood status of the study areas are labeled at an average level and the watershed which is developed and managed showed a slight improvement in terms of livelihood asset. Amongst each livelihood capital studied, social capital was the highest, while financial assets counted the lowest. The watershed development and management practices have significant positive relationships with all livelihood assets; natural capital has the highest while social capital has the lowest correlation, yet a statistically significant positive relationship existed.

The study applied the structural equation model to examine the effect of the practices of watershed development and management on agricultural productivity, income and employment generation, and social service and infrastructure; and resulted in a positive. As the community applied WDMPs, agricultural productivity, income and employment generation, and social service and infrastructure goes up by 55%, 49%, and 46%, respectively. This is besides any direct (unmediated) effect that WDMP may have on agricultural productivity, income and employment generation, and social service and infrastructure.

The study forwards first, to enhance agricultural productivity in the watershed more natural and social capital are needed. Second, to improve the social service and infrastructure of the study area more natural, social, and physical capital are required. Thirdly, to increase the income and employment generation opportunities in the study area more human, financial, physical, and natural capitals are compulsory. The increasing benefit of watershed development and management practices helps households to increase human capital, financial capital, physical capital, natural capital, and social capital in the study area. As a recommendation, policymakers should provide more livelihood-oriented policies in watershed areas to improve their households' livelihood assets to raise agricultural productivity, income and employment generation, and social service and infrastructure.

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