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Situational Analysis and Theory of Change Proposed Framework for Resilient and Sustainable Ecosystem Services of Conner, Apayao Watershed

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ABSTRACT

This study examines the situational analysis of the Conner watershed of Apayao as a basis for a theory of change framework for planning, implementing, and evaluating the said watershed. The objectives aimed to characterize the Conner Watershed as to its physical, biological, and socio-economic profiles; determine the drivers of change of ecosystem services within the watershed; and propose a Theory of Change Framework for sustainable ecosystem services within the watershed. Data gathering was performed through analysis of secondary data and techniques of Participatory Rural Appraisal, such as Key Informant Interviews and field work. Data analysis was conducted through mapping for visualization and spatial interpretation of the watershed and its key characteristics. Findings from these participatory and spatial analyses provided the basis for identifying ecosystem drivers and informing the development of the Theory of Change framework. The diversity indices were determined using Shannon-Wiener diversity and Simpson's dominance indices. The Conner watershed occupies an area of 73,665 hectares and covers 20 barangays of Conner. The floral diversity index was 2.61 (Shannon) and 0.8980 (Simpson), indicating moderate diversity. Issues and problems within the Conner Watershed impacted the forest areas of the watershed. The six Strategic Approaches (SAs) were developed through the Theory of Change: Improve Watershed Vegetation; Provide Alternative Livelihood; Improve Information, Education, and Communication; Enhance Capacity for Law Enforcement; Improve Social and Human Capital Development; and Enhance Research and Technology Development. Overall, the theory of change framework provides a structured basis for sustainable watershed management and informed policy development in Conner, Apayao.

Keywords: Watershed; Theory of Change; Ecosystem Services

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1. Introduction

The total forest cover of Apayao that as reflected in the report of the Forest Management Bureau, 2010, is 218,340 hectares with a closed forest area of 118,982 hectares and an open forest area of 99,358 hectares. Conner, Apayao shares a forest zone of 83,466.12 hectares. The municipality of Conner is traversed by three sub-watersheds fed by several tributaries springing from the mountainside. These three sub-watersheds are the Acutan River, the Nabuangan River, and the Barren River. These river systems merge at Matalag Bridge, draining to the Chico River and joining the Cagayan River before exiting to the Babuyan Channel. The river systems are the source of water for the Communal Irrigation Projects (CIPs), supplying water to about 1000 hectares of developed irrigated lands in the municipality. These river systems also have the potential for hydropower development, especially since the watershed areas are still covered with intact natural forest vegetation, which can sustain year year-round surface water supply (CLUP-MLGU-Conner, 2017–2027). Rivers provide important ecosystem services, such as water supply for domestic and industrial, recreational, agricultural, and environmental uses, which directly support communities. They serve as pillars for both community livelihoods and ecological balance [1]. Thus, rivers are characterized as a cornerstone to both biodiversity and human societies [2]. An interconnected meta-ecosystem, where ecological health and community resilience are shaped by both local and global systems—from hydrology to political economy [3].

Within the past five years, results of studies have continually documented land-use change (deforestation, agricultural expansion, and urbanization) as a major driver of watershed degradation [4,5]. Expanded cultivation increased sediment accumulation and organic matter deposition in the reservoir [6]. Further, a widely cited review demonstrates that nutrient loadings from agriculture (N and P fertilizers) and wastewater effluents are major drivers of eutrophication in freshwaters, with implications for water quality across catchments [7].

Large reservoirs change the hydrological regime by reducing flow variability, increasing water residence time, and disrupting sediment and nutrient fluxes, thereby affecting downstream geomorphology and ecosystem services [8]. Finally, intense rainfall events driven by climate change substantially increase surface runoff and erosive energy, resulting in greater soil detachment and sediment yield, especially under extreme precipitation conditions [9]. In addition, climate-driven changes in temporal rainfall patterns can significantly increase sediment discharge by elevating fine sediment supply and suppressing bed armoring in mountain rivers [10].

The literature consistently shows that watershed degradation is driven by multiple, interacting biophysical, socio-economic, and governance pressures, and that addressing these complex dynamics requires integrated and adaptive watershed management strategies that coordinate ecological, social, and economic objectives. Reviews highlight the evolution of integrated watershed management frameworks that consider landscape, institutional, and stakeholder interactions [11] and emphasize the need for adaptive approaches that respond to changing environmental conditions and pollutant sources [12].

To sustain the provision of the ability of the watershed to provide ecological services, managing the watershed must consider a holistic approach by taking into consideration the protective, conservation, and development strategies. Well-managed forest protected areas are essential for providing sustainable, high-quality water supplies to downstream communities [13]. The importance of integrating forest management with water resource planning to ensure the long-term sustainability of watershed ecosystem services [14].

Dudley [15] reported that enhancing the management of ecosystems is important in meeting both human and ecological well-being. This will contribute to attaining sustainable development. This can be achieved by addressing all the challenges through integrated watershed management approaches that combine ecological conservation with community- based development strategies.

To sustain the provision of the ecosystem services of Conner Watershed in the study site, it is therefore imperative to develop a mechanism of protection and conservation through the Theory of Change. This will provide a framework for planning, implementing, and evaluating programs, projects, and activities of watershed management. It provides guidance in terms of strategically linking ecological and human well-being within the watershed. Objectives: 1. Characterize the Conner Watershed as to its physical, biological, and socio-economic profiles; 2. Determine the drivers of change of ecosystem services within the watershed; and 3. Proposed a Theory of Change Framework for sustainable ecosystem services within the watershed.

2. Materials and Methods

2.1. Location

The Conner Watershed covers 73,665 hectares across nine municipalities and 58 barangays, located at approximately 17°48'0" latitude and 121°20'0" longitude (**Figure 1**). It is bounded by Kabugao (Apayao) in the north, Kalinga in the south, Cagayan in the east, and Abra in the west. Conner Municipality accounts for the largest portion, occupying 79% of the total area. Beyond its ecological importance, the watershed also acts a vital socio-economic role by supporting agriculture, forestry, and water resources that sustain local livelihoods. Its tributaries across several municipalities signifies the need for join management to enhance both environmental sustainability and community development.

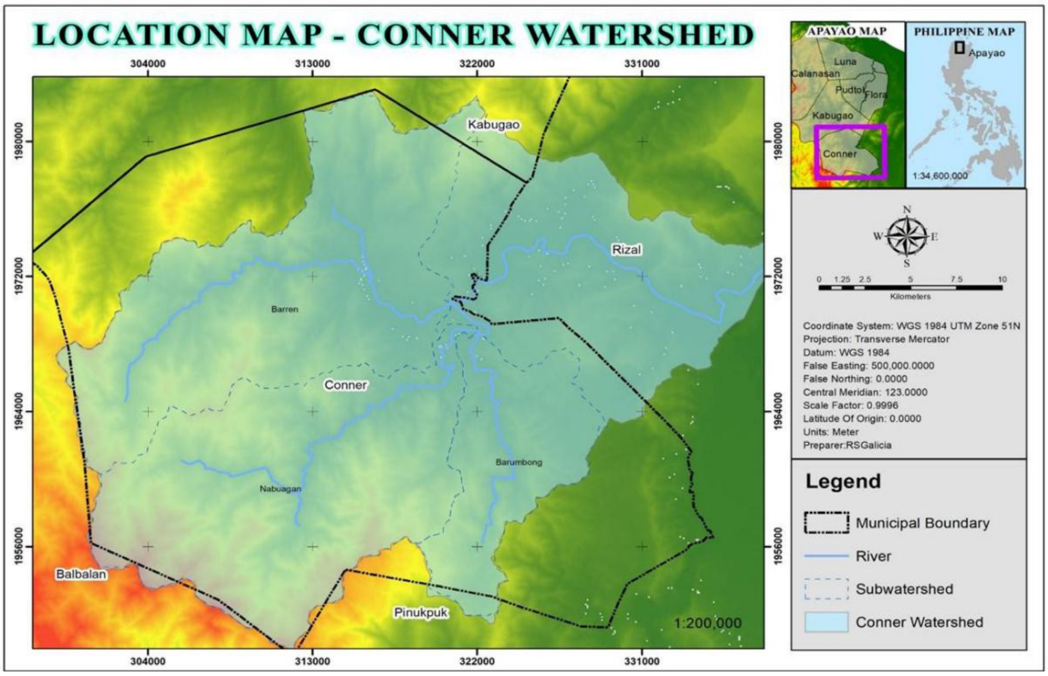

Figure 1. Map of Conner, Apayao.

2.2. Data Gathering Procedure, Sources, and Methods

Secondary data concerning the physical profile of the study area, such as area, location, access, climate, topography, drainage, slope, elevation, soil type, soil erosion vulnerability, flood vulnerability, landslide vulnerability, and forest land use, primary forests, and tree cover loss, including the socio-economic profiles of the watershed, was gathered through.

Various documents from the years 2020–2022 are coming from government agencies such as the Department of Environmental and Natural Resources (DENR), Department of Agriculture (DA), Bureau of Soil and Water Management(BSWM), and National Mapping and Resource Information Authority (NAMRIA).

Several field works, such as the establishment of plots for floristic diversity and carbon stock assessment, were done. A sampling intensity of 5% of the area was considered for the setup of the plots. A baseline was established. Five strips were laid across the baseline. The interval between two adjacent strips was 100 m. In each strip, 10 quadrats were placed, 5 each on both sides of the baseline. The dimension of the quadrat was 10 m by 10 m (100 m^2). The interval between the 2 quadrats was 10 m. The 11 quadrats were used to gather data on tree species. Tree species and understorey vegetation were recorded down to species level. Biometrics such as diameter at breast height (cm), total height (m), merchantable height (m), crown diameter (m), number of regenerations, and other biophysical features were also noted.

2.3. Data Analysis

Basically, the data was analyzed using both qualitative and quantitative methods. The Geographic Information System (GIS), which is a powerful tool capable of processing spatial or geographically-based information [16] was used in the production of thematic maps. The GIS version used was ArcGIS 10.4. ArcGIS 10.4 is a desktop GIS application from Esri, released in 2016. The key techniques considered in developing the maps of this study were data preparation and management, layer symbolization, labeling and annotation, map layout and design, and use of basemaps. The thematic maps were generally for the visualization of spatial data to support decision-making, planning, and environmental monitoring by helping stakeholders understand spatial patterns and relationships.

Floral Diversity and Dominance Index Analysis was determined by using the diversity indices of the Shannon-Weiner diversity index and Simpson's Dominance index. The Shannon–Weiner Index (H') highlights diversity and evenness, showing how wide ranging and harmonious a forest community is. The Simpson's Dominance Index (SDI) emphasizes dominance and concentration, showing whether a few species overwhelmingly control the ecosystem. Together, these indices shows a comprehensive understanding of forest biodiversity, important for ecological assessment and sustainable forest management. The following is the formula of the said diversity indices:

Computation of Diversity Index of Trees

$$\text{Diversity Index (H')} = -\sum_{i=1}^{n} (p_i \times \text{LN } p_i)$$

where H' = Shannon-Weiner diversity index,

pi = proportion of IVs belonging to the i-th species,

LN = natural logarithm.

Computation of Dominance Index of Trees

$$\text{Dominance Index (SDI)} = \frac{\sum n_i(n_i - 1)}{N(N - 1)}$$

where: SDI = Simpson's Dominance index,

ni = importance value of species A,

N = total importance values of all species.

3. Results and Discussions

3.1. Physical Profile of Conner Watershed

3.1.1. Location Area and Access

The Conner Watershed (**Figure 2**) is geographically located at approximately 17°48′0″ N latitude and 121°20′0″ E longitude. It occupies a total area of about 73,665 hectares and covers 58 barangays distributed across nine municipalities: Balbalan, Conner, Kabugao, Lacub, Piat, Pinukpuk, Rizal, Santo Niño, and Tineg (**Table 1**). Administratively, the watershed is bounded on the north by the Municipality of Kabugao in Apayao, on the south by the Province of Kalinga, on the east by the Province of Cagayan, and on the west by the Province of Abra. The watershed constitutes part of the Upper Conner River Basin (UCRB), which defines its hydrological boundary and drainage pattern.

3.1.2. Climate

Based on the Modified Coronas Classification, the climatic type of the Conner watershed is Type IV (**Table 2** and **Figure 3**). Rainfall is evenly distributed throughout the year, with no distinct dry seasons. Constant precipitation promotes sustained infiltration, continuing groundwater levels, and supplies agricultural and domestic water needs [17], but also increases the risk of surface runoff and sediment transport in steeply sloped areas of the watershed.

3.1.3. Topography

The majority of the Municipality of Conner is characterized by steep to severely steep slopes. As shown in **Table 3**, approximately 15,027 hectares are classified as hilly or very steep (30–50% slope), while about 19,733 hectares fall under the severely steep category (above 50% slope). According to the Food Agriculture O (2021), universally applied slope classification systems categorize terrain into five classes: nearly level, gently sloping, moderately steep, steep, and very steep. Areas with slopes greater than 20% are typically considered steep to very steep and are highly susceptible to erosion. Empirical studies show that slopes between 25° and 40° experience the highest soil erosion rates due to accelerated surface runoff and reduced water infiltration capacity.

Table 1. Area coverage of the Conner Watershed.

Municipality	No. of Barangays Covered	Area Covered (ha)	Area Covered (%)
Balbalan	2	517	1
Conner	20	58,143	79
Kabugao	1	1064	1
Lacub	1	21	0
Piat	3	112	1
Pinukpok	2	481	1
Rizal	27	12,832	17
Santo Nino	1	362	0
Tineg	1	133	0
Total	58	73,665	

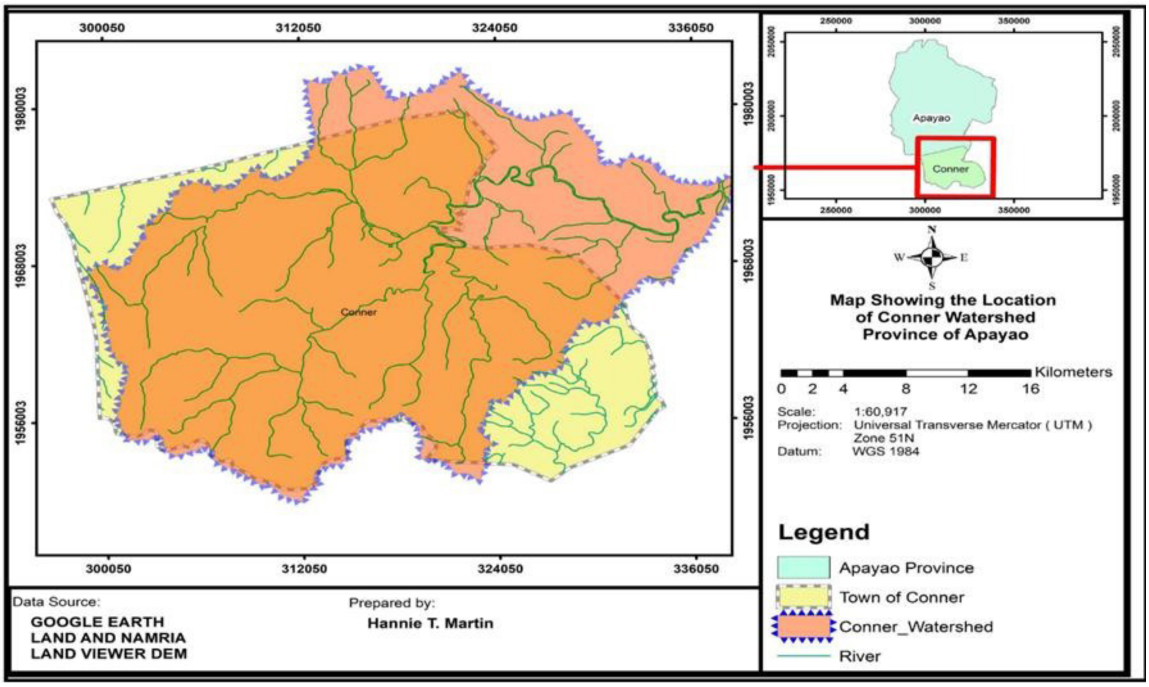

Figure 2. Location Map of Conner Watershed, Apayao.

Table 2. Average rainfall in Conner Watershed (mm).

Month	Rainfall, mm (2010–2014)					Ave.
	2010	2011	2012	2013	2014	
January	15.29	68.5	65.3	43.2	0	38.58
February	0	6.1	94.9	27.8	20.1	29.78
March	6.1	19.5	72.8	66.5	15.5	36.08
April	70.8	21.3	46.1	195.7	75.1	81.8
May	78.1	291.3	130.7	79.4	54.4	126.78
June	129.4	25.7	310.9	157.5	185.8	161.86
July	147.5	121.3	235.5	141.5	158.4	160.84
August	98.3	425.6	296.1	156.1	139.6	223.14
September	126.9	299.8	117.9	206.8	302.9	210.86
October	270.1	279.9	215.6	203	182.9	230.3
November	720.9	387.2	52.6	298.1	93.8	310.52
December	48.8	330.8	88.7	99.8	99.1	133.44
Total	1713	2277	1727	1675	1328	1744
Average	142.73	189.75	143.93	139.62	110.63	145.33

Source: PAG-ASA.

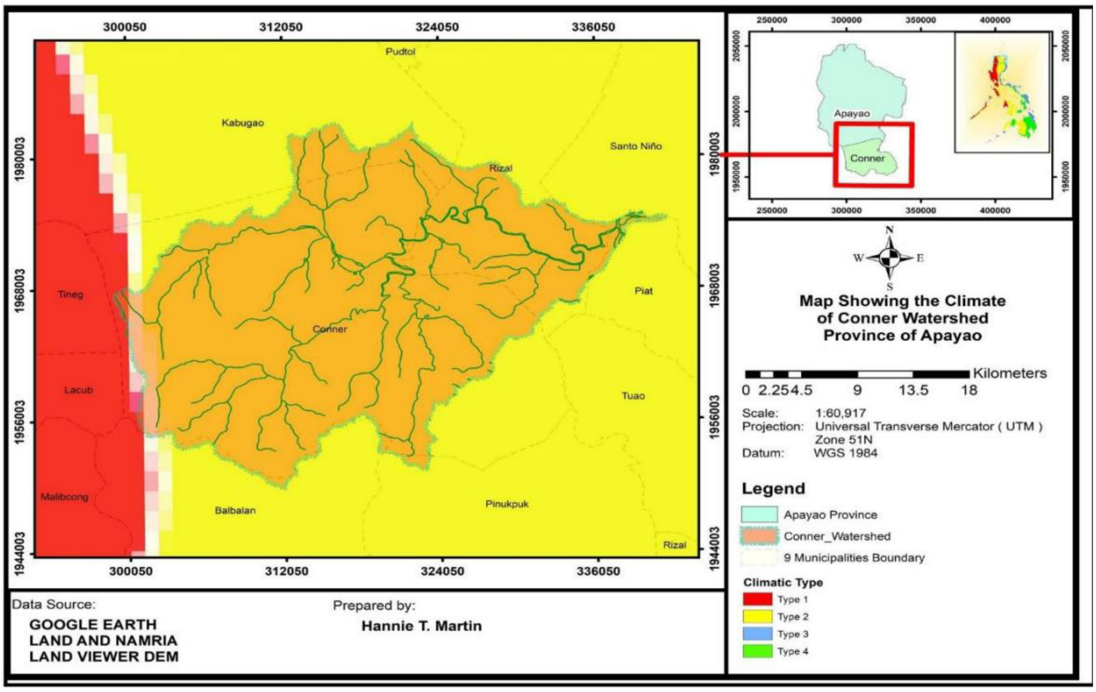

Figure 3. Climatic Map of Conner Watershed, Apayao.

Table 3. Distribution of area of Conner Watershed by slope classes (ha).

Municipality	Slope Class					Total
	0–8%	8–18%	18–30%	30–50%	Above 50%	
	Gently Sloping	Moderate	Steep	Hilly/Steep	Severely Steep	
Conner	5641	7296	10,445	15,027	19,733	58,143

Source: NAMRIA 2015.

In the context of the Conner Watershed, these slope characteristics imply a high vulnerability to soil erosion and sediment transport, particularly during periods of heavy rainfall. The steep terrain limits the establishment of stable vegetation cover, reduces soil retention, and increases the likelihood of landslides and sedimentation in downstream river systems [18]. Therefore, slope management practices such as reforestation, contour farming, and soil stabilization measures are critical to maintaining the watershed's ecological stability and sustaining its ecosystem services.

3.1.4. Drainage Network

The Conner Watershed drains into five major river systems—Bagombong River (6 km), Baren River (24 km), Chico River (34 km), Nabuangan River (22 km), and Purag River (27 km) (**Table 4** and **Figure 4**). Collectively, these rivers form an extensive hydrological network that supplies water to 99% of the barangays in the Municipality of Conner.

This wide coverage indicates that the Conner Watershed serves as the primary source of water for domestic, agricultural, and ecological functions within the municipality. The interconnected river systems play a vital role in supporting irrigation, sustaining local livelihoods, and maintaining aquatic biodiversity. However, this also means that any form of watershed degradation—such as deforestation, erosion, or pollution—could have widespread downstream impacts, affecting nearly the entire population and ecosystem dependent on these rivers. Therefore, integrated watershed management is essential to safeguard water availability and quality for both community use and environmental sustainability.

Table 4. Drainage network of Conner Watershed in length (m and km).

River Name	Length (m)	Length (km)
Bagombong River	16,408	16
Barren River	24,271	24
Chico River	34,077	34
Nabuangan River	21,876	22
Purag River	27,120	27
Total	123,752	147

Source: NAMRIA 2015.

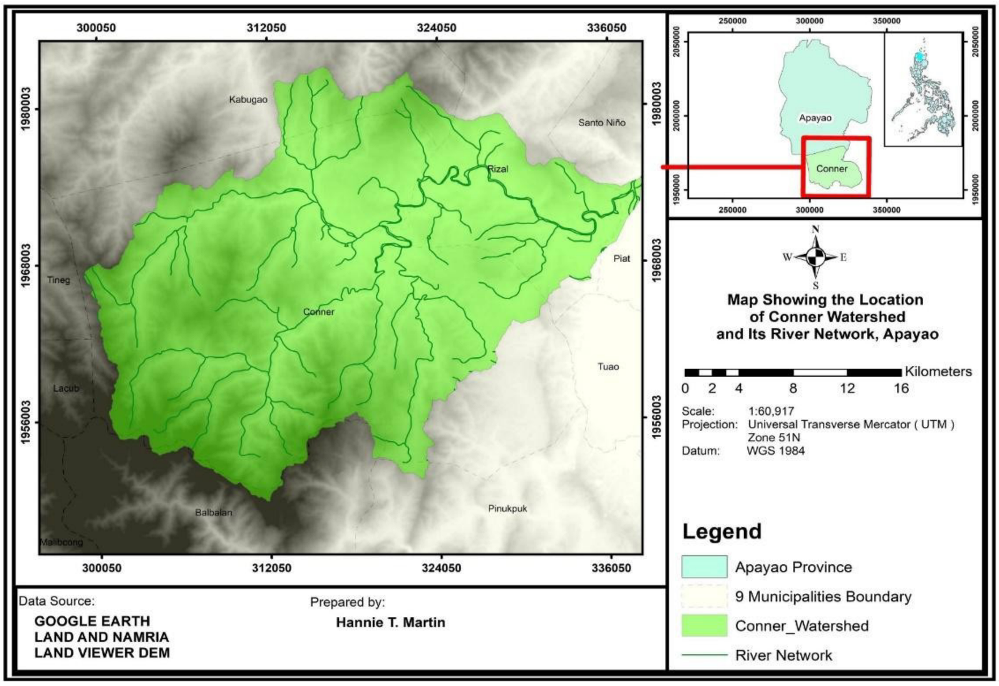

Figure 4. Drainage Map of Conner Watershed, Apayao.

3.1.5. Landslide Vulnerability Assessment

Based on **Figure 5**, landslides pose a serious threat to approximately 22% of the total area of the Conner Watershed (**Table 5**). The spatial distribution of landslide vulnerability, illustrated through color-coded mapping, reveals that large portions of the watershed are at moderate to high risk, particularly in areas characterized by steep slopes and fragile soil structures. This indicates that topography and land-use practices play crucial roles in the watershed's overall stability.

The occurrence of downslope movements and slope failures significantly contributes to increased sediment flow into rivers and reservoirs, elevating turbidity and accelerating siltation that in turn, diminishes water storage and irrigation capacity. For example, rainstorm-triggered landslides in the Shihmen Reservoir watershed delivered large volumes of sediment to the reservoir and caused rapid increases in turbidity during typhoon events [13], and landslide-driven sediment inputs were shown to dominate overall sediment yields in the same watershed, with a high percentage of slope-derived material delivered downstream [19].

Moreover, recurring landslides can lead to the loss of forest cover, destruction of aquatic habitats, and a subsequent decline in biodiversity, which collectively disrupt the ecological balance of the watershed ecosystem [20]. This highlights the need for integrated slope stabilization measures, reforestation of vulnerable areas, and strict land-use management to mitigate landslide risks and preserve the watershed's ecological integrity.

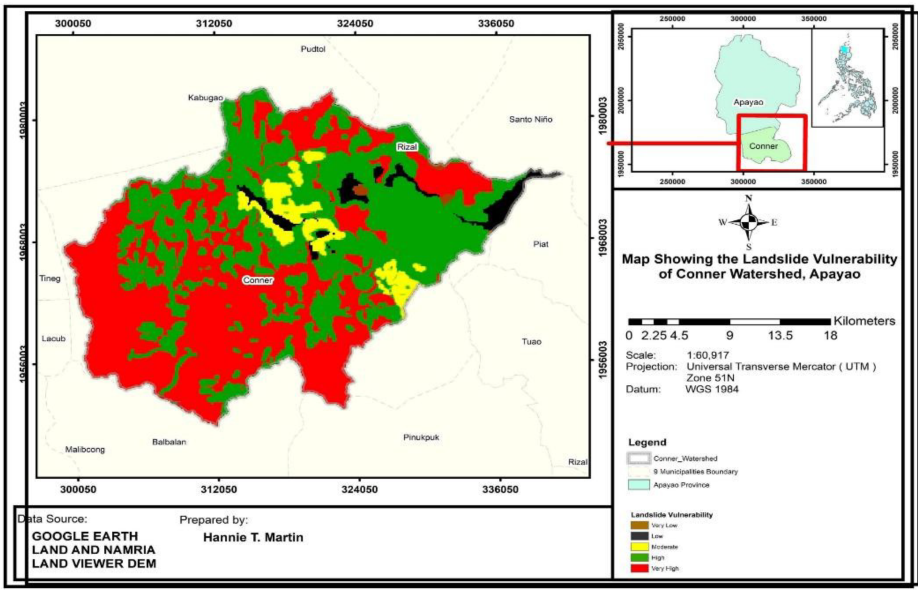

Figure 5. Landslide Vulnerability Map of Conner Watershed, Apayao.

Table 5. Observed landslide vulnerability of Conner Watershed.

Category	Area Coverage (ha)	Percentage
Low	3502	5%
Moderate	53,840	73%
High	16,321	22%
Total	73,664	100%

Source: NAMRIA 2015.

3.2. The Biological Profile of Conner Watershed

3.2.1. Vegetation Composition

In terms of vegetation composition of the watershed, there were 22 species of trees with 264 individuals belonging to 16 genera under 10 families. **Table 6** shows the common names, scientific names, and family names of the identified tree species, including their ecological status (**Table 6**). It could be noted that Dipterocarp species dominate the vegetative composition, followed by Anacardiaceae, Moraceae, Meliaceae, Ulmaceae, Fabaceae, Phyllanthacea, Lauraceae, and Fagaceae.

Dipterocarp is known as an endemic and commercially important species in the countries [16]. These species are also the main source of premium species, commonly referred to as "lauan," "tanguile," and "apitong," which have long been vital to the country's wood industry [21]. In general, the families are environmentally important in sustaining the forest diversity, economically beneficial for agriculture and industry, and culturally vital in the countries' traditional medicine and culinary traditions.

The ecological status of the vegetation is endangered, vulnerable, or nearly threatened, and of least concern. The ecological status of trees serves as important knowledge in terms of the health and sustainability of forest ecosystems. It acts as a major indicator of biodiversity, intact habitat, and ecosystem functions such as carbon sequestration, nutrient cycling, and hydrological regulation. Assessing the ecological status helps determine the degree of disturbance, resilience, and potential degradation of forested landscapes.

Table 6. List of tree species recorded in Nabuangan, Conner, Apayao.

Common Name	Scientific Name	Family	Ecological Status	Sources
Almon	Shorea almon	Dipterocarpaceae	Near Threatened	IUCN 2019
Apitong	Dipterocarpus grandifloras	Dipterocarpaceae	Endangered	IUCN 2017
Bagtikan	Parashorea malaanonan	Dipterocarpaceae	Least Concern	IUCN 2019
Dalingdingan	Hopea foxworthi	Dipterocarpaceae	Endangered	IUCN 2019
Dao	Dracontomelon dao	Anacardiaceae	Least Concern	IUCN 2019
Guijo	Shorea guiso	Dipterocarpaceae	Vulnerable	IUCN 2017
Hagimit	Ficus magnifolia	Moraceae	Least Concern	IUCN 2018
Kalantas	Toona kalantas	Meliaceae	Data deficient	IUCN 2017
Lamio	Dracontamelon edule	Anacardiaceae		
Mayapis	Shorea squamata	Dipterocarpaceae	Least Concern	IUCN 2019
Magabuyo	Celtis luzonica	Ulmaceae	Vulnerable	IUCN 1998
Mangachapiu	Hopea acuminata	Dipterocarpacea	Vulnerable	IUCN 2019
Narra	Pterocarpus indicus	Fabaceae	Endangered	IUCN 2018
Palosapis	Anisoptera thurifera	Dipterocarpaceae	Vulnerable	IUCN 2017
Red Lauan	Shorea negrosensis	Dipterocarpaceae	Least Concern	IUCN 2019
Tindalo	Afzelia rhomboidei	Leguminosae	Vulnerable	IUCN 1998
Tuai	Bischofia javanica	Phyllanthacea	Least concern	IUCN 2018
Ngarusangis	Cryptocarya cagayanensis	Lauraceae	Near Threatened	IUCN 2020
Tanguile	Shorea polysperma	Dipterocarp	Least Concern	IUCN 2018
Ulayan	Lithocarpus sulithi	Fagaceae	Least Concern	IUCN 2020
White Lauan	Shorea Contorta	Dipterocarpaceae	Least Concern	IUCN 2019
Yakal	Shorea astylosa	Dipterocarpaceae	Endangered	IUCN 2019

3.2.2. Species Density and Dominance

The Shannon-Wiener Index result is 2.61 as reflected in **Table 7**. This implies that the watershed has moderate floral diversity based on the classification scheme developed by Fernando et al. [22]. With regard to the dominance index, the result was 0.8980, which also supported the previous claim of moderate diversity. The overall result of the floral diversity index means that the area is partly disturbed. This might be attributed to kaingin making, as revealed by the reconnaissance survey done by the researcher. Lesser tree diversity decreased forest resilience against pests, diseases, and climate change. Disturbances undermine ecosystem functions like carbon sequestration, soil protection [23], alter water yield, and sediment load [24]. Therefore, the forests of the Conner watershed must be prioritized for protection and conservation to sustain ecosystem services.

3.2.3. Faunal Species

Table 8 provides the list of faunal species that could be found in Nabuangan. Nine types of faunal species are present in the area. In addition, 14 types of Aves are observed in the area (**Table 9**). The ecological status of the faunal species is vulnerable, endangered, nearly threatened, and of least concern. Faunal species play a vital role in maintaining ecosystem balance and functionality. They contribute to important ecological processes such as pollination, seed dispersal, pest control, and nutrient cycling, which sustain biodiversity and productivity [25]. Moreover, the presence and abundance of faunal species serve as indicators of ecosystem health and resilience, reflecting the integrity of habitats and the level of anthropogenic disturbance [26].

Table 7. Species diversity and dominance indices.

Particular	Shannon-Weiner Index	Simpson's Dominance Index
Tree Species	2.617282604	0.089805184

Table 8. List of Animal Species found within the Conner Watershed.

Local Name	Common Name	Scientific Name	Ecological Status	Sources
Ayong	Monkey	*Macaca philippinensis*	Endangered	IUCN 2022
Buwet	Tree squirrel	*Callosciurus philippinensis*	Least Concern	IUCN 2016
Ugsa	Deer	*Cervus sp*	Vulnerable	IUCN 2014
Mutit	Wild Cat	*Vivera tangulunga*	Least Concern	IUCN 2015
Siley	Monitored Lizard	*Varanus indicus*	Vulnerable	IUCN 2021
Bahlat	Snake	*Lampropetis getulus*	Least Concern	IUCN 2016
Minugung	Rough green snake	*Boiga dendrophilla*	Least Concern	IUCN 2007
Tekka	Chameleon	*Chameleon sp.*	Least Concern	IUCN 2017
Alipat	Lizard	*Palmatogecko ranger*	Least Concern	IUCN 2019
Labuyo	*Gallus gallus*	Phasianidae	Least Concern	IUCN 2016
Slendered- billed crow	*Corvus enca*	Corvidae	Least Concern	IUCN 2016
Philippine Falconet	*Microhierax Erythrogenys*	Falconidae	Least Concern	IUCN 2016
Chinese Egret	*Egretta eulophotes*	Pelicanidae	Vulnerable	IUCN 2016
North Philippine Dwarf- kingfisher	*Ceyx melanurus*	Pelicanidae	Vulnerable	IUCN 2016
Philippine Pygmy Woodpecker	*Picoides maculatus*	Pelicanidae	Least Concern	IUCN 2016
Asian Woollyneck	*Ciconia episcopus*	Pelicanidae	Near Threatened	IUCN 202
Philippine Hanging-parrot	*Loriculus philippensis*	Psittaculidae	Least Concern	IUCN 2016
Crested Myna	*Acridotheres cristatellus*	Pelicanidae	Least Concern	IUCN 2016
Northern Rufous Hornbill	*Buceros hydrocorax*	Bucirotidae	Vulnerable	IUCN 2020
Philippine Eagle-owl	*Bubo philippensis*	Tytonidae	Vulnerable	IUCN 2016
Chestnut Munia	*Lonchura atricapilla*	Estrildidae	Least Concern	IUCN 2016
North Philippine Hawk-eagle	*Nisaetus philippensis*	Accipitridae	Endangered	IUCN 2016
Swiflete	*Collocalia swiflet*	Apodidae	Least Concern	IUCN 2016

Table 9. Demographic Profile per Barangay of Conner Watershed, Year 2015–2020.

Barangay	Population Percentage (2020)	Population (2020)	Population (2015)	Change (2015–2020)	Annual Population Growth Rate (2015–2020)
Allanigan	2.07%	569	494	15.18%	3.02%
Banban	4.28%	1178	1088	8.27%	1.69%
Buluan	6.13%	1690	1537	9.95%	2.02%
Caglayan	8.68%	2392	2132	12.20%	2.45%
Calafug	3.81%	1050	1041	0.86%	0.18%
Cupis	1.66%	456	446	2.24%	0.47%
Daga	4.78%	1316	1315	0.08%	0.02%
Guinaang	5.23%	1442	1507	−4.31%	−0.92%
Ili	4.69%	1293	1325	−2.42%	−0.51%
Karikitan	6.90%	1901	1879	1.17%	0.25%
Katablangan	2.36%	650	559	16.28%	3.23%
Malama	12.13%	3343	2979	12.22%	2.46%
Manag	6.82%	1878	1771	6.04%	1.24%
Mawigue	2.80%	772	800	−3.50%	−0.75%
Nabuangan	2.10%	578	528	9.47%	1.92%
Paddaoan	5.97%	1646	1678	−1.91%	−0.40%
Puguin	2.92%	804	859	−6.40%	−1.38%
Sacpil	5.11%	1408	1230	14.47%	2.89%
Talifugo	3.76%	1036	1106	−6.33%	−1.37%
Conner Total		27,552	26,051	5.76%	1.19%

Socio-Demographic Profile of the Conner Watershed

Table 9 shows that the Conner Watershed has a total population of 27,552 for the year 2020. Out of twenty, Barangay Malama recorded the highest population with 3343, followed by Caglayan with 2392 and Karikitan with 1901 population. It could be noted that there is an increase of 5.61% for the period of 2015–2020 with an average annual growth rate of 1.19%.

3.2.4. Income Sources

The majority of the income sources of the population covered by the watershed are primarily agriculture, forestry, and fishing as the primary source of income (**Table 10**). Based on the interview, the main crops planted are corn, rice, banana, fruit trees associated with vegetables, and root crops. Other main sources of income were Public Administration and Defense, Compulsory Social Security, and construction.

Table 10. Sources of Income.

Industry Group	Frequency			Percent	
	Full-Time Employment (Worked 40 h or More)	Part-Time Employment (Worked Less than 40 h)	Total	Full-Time Employment (Worked 40 h or More)	Part-Time Employment (Worked Less than 40 h)
Agriculture, Forestry, and Fishing	4814	1293	6107	78.83	21.17
Mining and Quarrying	45	14	59	76.27	23.73
Manufacturing	150	32	182	82.42	17.58
Electricity, Gas, Steam and AirConditioning Supply	4	0	4	100.00	0.00
Construction	839	54	893	93.95	6.05
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	668	103	771	86.64	13.36
Transportation and Storage	195	43	238	81.93	18.07
Accommodation and Food Service Activities	76	10	86	88.37	11.63
Information and Communication	18	1	19	94.74	5.26
Financial and Insurance Activities	20	3	23	86.96	13.04
Real Estate Activities	1	1	2	50.00	50.00
Professional, Scientific andTechnical Activities	31	1	32	96.88	3.13
Administrative and Support Service Activities	140	14	154	90.91	9.09
Public Administration and Defense; Compulsory Social Security	937	80	1017	92.13	7.87
Education	441	14	455	96.92	3.08
Human Health and Social Work Activities	180	20	200	90.00	10.00
Arts, Entertainment and Recreation	19	2	21	90.48	9.52
Other Service Activities	170	45	215	79.07	20.93
Activities of Households as Employers; Undifferentiated Goods-and Services-producing Activities of Households for Own Use	16	8	24	66.67	33.33
Water Supply; Sewerage, Waste Management and Remediation Activities	0	2	2	0.00	100.00
Total	8764	1740	10,504	83.43	16.57

Source: 2022 Community-Based Monitoring System (CBMS), Philippine Statistics Authority.

3.2.5. Access to Basic Services

The majority of the households have access to electricity, transportation, and clean water. Sources of water are traditional, such as springs and rivers. There are primary schools, health centers, and birthing areas within accessible barangays. Road construction is still ongoing for the far-flung barangays, making it difficult to transport their products, especially during the rainy season. Infrastructures are limited only to the lower part of the watershed. The limitation of access to basic services, especially in the far-flung barangays, contributes to the vulnerability of households to poverty.

3.2.6. Key Issues within the Watershed

The Conner Watershed stakeholders have encountered several issues that pose implications for its management (**Table 11**). Results of focus group discussion revealed that the factors identified that contributed to the forest degradation in the watershed are increasing population of informal forestland settlers; lack of livelihood opportunities; Absence of Payment for Ecosystem Services (PES); inadequacy of plans and programs to protect the forest; poor enforcement of laws and regulations; poor governance, and lack of adequate database and scientific information.

Table 11. Issues and Problems.

Issues and Problems	Implications
Increasing population of informal forestland settlers	This contributes to deforestation as it will increase settlements.
Lack of livelihood opportunities	This will contribute to deforestation through kaingin making, land use conversion, and mining
Lack of implementation of plans and programs to protect the forest	This will not be able to fully address the deforestation and forest degradation, such as illegal logging or timber poaching, including calamities
Absence of Payment for Ecosystem Services (PES)	This will not be able to fully address deforestation and forest degradation, such as illegal logging or timber poaching, including calamities
Poor enforcement of laws and regulations, and poor governance	This will not be able to fully address deforestation and forest degradation, such as illegal logging or timber poaching, including calamities
Lack of an adequate database and body of scientific information	Lack of foundation for effective watershed management.

The increasing number of informal settlers in forestlands has important implications for watershed health and sustainability. Population expansion in these areas often resulted in land clearing for agriculture, settlement, and resource extraction, resulting in forest degradation, biodiversity loss, and reduced watershed functionality [16]. Conversion of forest to agriculture/other land uses significantly increases runoff, sediment, and basic water quality indicators (e.g., TDS and EC), illustrating mechanisms linking forest loss and water degradation [27]. Households with limited livelihood opportunities prioritize short-term survival needs, which weakens support for conservation initiatives [28].

When policy enforcement is inadequate, institutional capacity is low, and secure access to forest benefits is lacking, forest resources continue to be degraded even under conservation mandates [29]. Ultimately, the lack of program implementation not only degrades ecosystems but also undermines human well-being and national development goals.

3.2.7. Drivers of Deforestation and Forest Degradation within the Watershed that Affect Ecological Services

Based on the Key informant interviews conducted, the results of the drivers of deforestation and forest degradation are presented in **Table 10**, wherein the main driver is the agricultural expansion of kaingin making, followed by illegal logging and anthropological factors. For the indirect causes (**Table 12**), weak law enforcement ranked number one, followed by limited livelihood options and an increasing population. When forest laws are not enforced, people tend to gather trees and other resources within the watershed, without fear of punishment. Lack of livelihood and increase in population may increase the dependence of communities on forest resources, which can contribute to a faster rate of deforestation and forest degradation. With this, the ecosystem services offered by the watershed, such as provisioning, regulating, supporting, and cultural services, are affected by the identified drivers, disrupting the ecological functions and reducing the capacity of the watershed to support sustainable development for both human and ecological well-being.

Table 12. Drivers of Deforestation and Forest Degradation.

Direct Drivers	Ranked
Anthropological Factors	
● Climate Change, Typhoon, Food, Landslide	8
Infrastructure Development	
● Bridge Construction	7
● Road Construction	4
● Mining	3
Agricultural Expansion	
● Kaingin making	1
Forest Product Extraction	
● NTFP harvesting	5
● Fuelwood gathering	6
● Legal/illegal logging/poaching	2
Indirect Drivers	**Ranked**
Economic Market or Technological	
● Limited livelihood options	2
● High demand for wood	6
Socio-demographic cultural	
● Lack of knowledge	5
● Increasing population	3
● Increasing number of informal settlers in the forest	4
Policy-Institutional Governance	
● Poor forest management	7
● Peace and order problems	10
● Unclear policies	9
● Corruption	-
● Weak law enforcement	1
● Weak institutional capacities	8

3.3. Theory of Change Frameworks for Conner Watershed Management

The Theory of Change provides “a description of the logical causal relationships between multiple levels of conditions or interim results needed to achieve a long-term objective”. The "if-then relationships that link a strategic approach to intermediate results and the final desired impact" were made clearer by the results chains and the developed TOCs. In this study, the theory of change development will be based on the situation of the Conner Watershed.

Sustainably addressing the threats to the Conner watershed and drivers of its degradation will require many things, including revegetation, sustainable alternative livelihood, information, education, and communication, strong enforcement of environmental laws, social and human capital development, and strong research and technology development.

There were six objectives with corresponding strategic approaches that will address the diverse drivers and threats to ecosystems/habitats and flora, and fauna species. The six Strategic Approaches (SAs) are the following: Strategic Approach 1: Improve Watershed Vegetation; Strategic Approach 2: Provide Alternative Livelihood; Strategic Approach 3: Improve Information, Education, and Communication; Strategic Approach 4: Enhance Capacity for Law Enforcement; Strategic Approach 5: Improve Social and Human Capital Development; and Strategic Approach 6: Enhance Research and Technology Development.

3.3.1. Overall Theory of Change or Results Chain

The Theory of Change aids in presenting a continuum of outcomes that are anticipated to occur as a result of an intervention. The overall results chain described the Theory of Change of the six Strategic Approaches (**Figure 6**). It serves as a harmonizing framework for planning and implementation of the six Strategic Approaches activities. The overall result chain described how the six Strategic Approaches activities will collectively contribute to the intermediate results that will lead to the sustainability of ecosystem services through long-term outcomes and impacts within the watershed. These are expected to sustain and improve the habitats' provision of various ecosystem goods and services—supporting, provisioning, regulating, and cultural enrichment—for both human well-being and ecosystem interests.

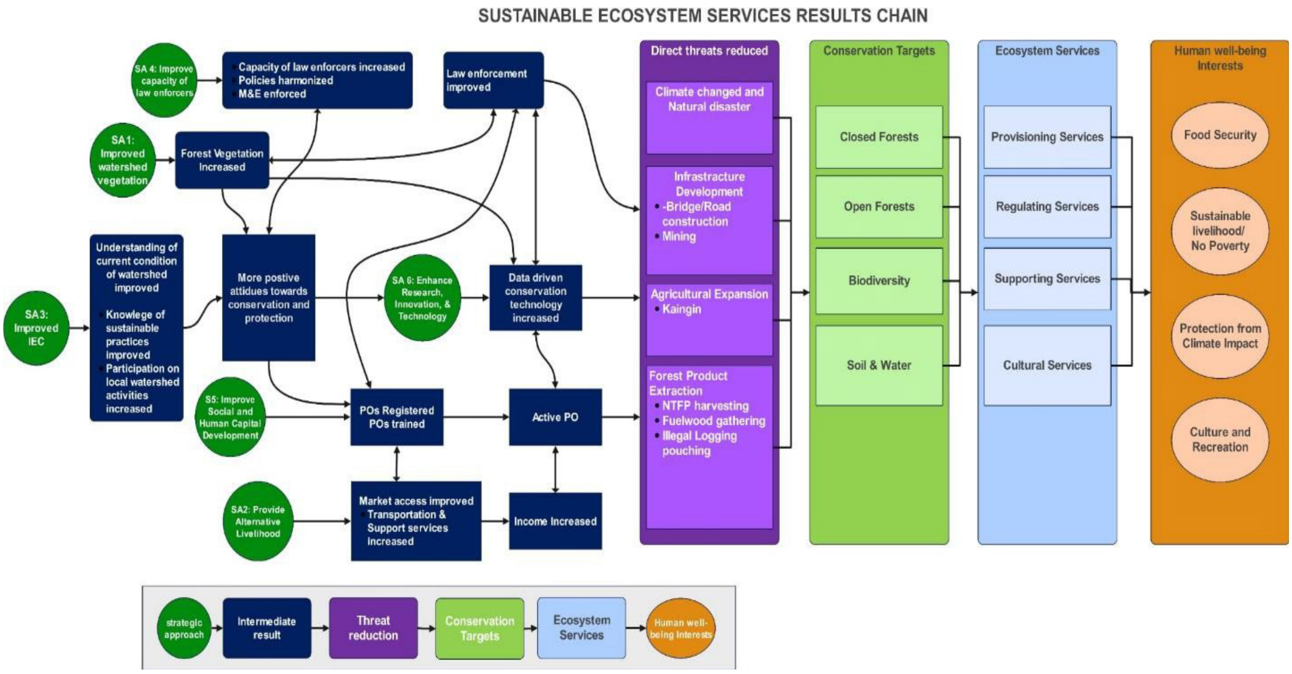

Figure 6. Overall Theory of Change or Result Chain.

Based on the refined overall results chains, the proposed theory of change is:

If communities, local government units, research and training institutions, and regulatory bodies and enforcers, the private sector, civil society organizations, and environmental groups understand the true economic value and sociocultural significance of the watershed, including their ecosystem functions and goods and services they provide as a combined result of

(1) Improved watershed vegetation leading to enhanced biodiversity, reduced soil erosion, improved water regulation, and strengthened the overall resilience of the watershed ecosystem.

(2) Provided Alternative Livelihood to the community for them to reduce dependence on forest resource extraction, lessening activities such as kaingin and illegal logging. This will create stable income sources, improve household well-being, and contribute to the recovery of forest cover and ecosystem services.

(3) Improved Information, Education, and Communication lead to an understanding of sustainable land use, forest protection, and climate change impacts. This will lead to greater participation in conservation activities, better compliance with environmental regulations, and collective action towards protecting and restoring watershed resources.

(4) Enhanced Capacity for Law Enforcement to imple-

ment policies and ordinances to reduce illegal logging, minimize kaingin practices, and better compliance with environmental laws, contributing to forest regeneration and the sustained provision of ecosystem services; and

(5) Improved Social and Human Capital will empower local communities through skills training, leadership development, and organizational strengthening. This increases community participation in watershed management, enhances livelihood opportunities, and fosters collective responsibility for conserving natural resources.

(6) Enhanced Research and Technology Development to improve access to scientific data and innovative conservation methods. This will lead to more effective watershed management strategies, adoption of sustainable farming technologies, and evidence-based decision-making that strengthens ecosystem restoration and resilience.

Then Conner watershed management can significantly contribute to the reduction of threats to habitats and to wildlife species, thereby, directly and indirectly enhancing capacities of the Conner watershed, to supply and provide ecosystem goods and services that benefit human and ecological well-being.

3.3.2. Strategic Approach 1: Improve Watershed Vegetation through Reforestation and Assisted Natural Regeneration

The CENRO-DENR intends to restore ecological stability and biodiversity conditions of degraded forest lands and protected areas in the Conner watershed. In degraded forest land and conservation areas that are above >50% and in strict protection zones of the protection area, restoration techniques may be used of reforestation or assisted natural regeneration (ANR). Reforestation species are preferably indigenous ones. In the ancestral domain area, appropriate indigenous and economically viable minor forest species such as bamboo and rattan may be interplanted in degraded forest lands as part of the reforestation strategy.

Key Results and Outcomes. **Figure 7** shows the results of improved watershed vegetation. The implementation of the Key results of various activities of reforestation and Assisted Natural Regeneration (ANR) is expected to improve forest vegetation within the watershed. These actions have enhanced biodiversity, reduced soil erosion, improved water regulation, and strengthened the overall resilience of the watershed ecosystem.

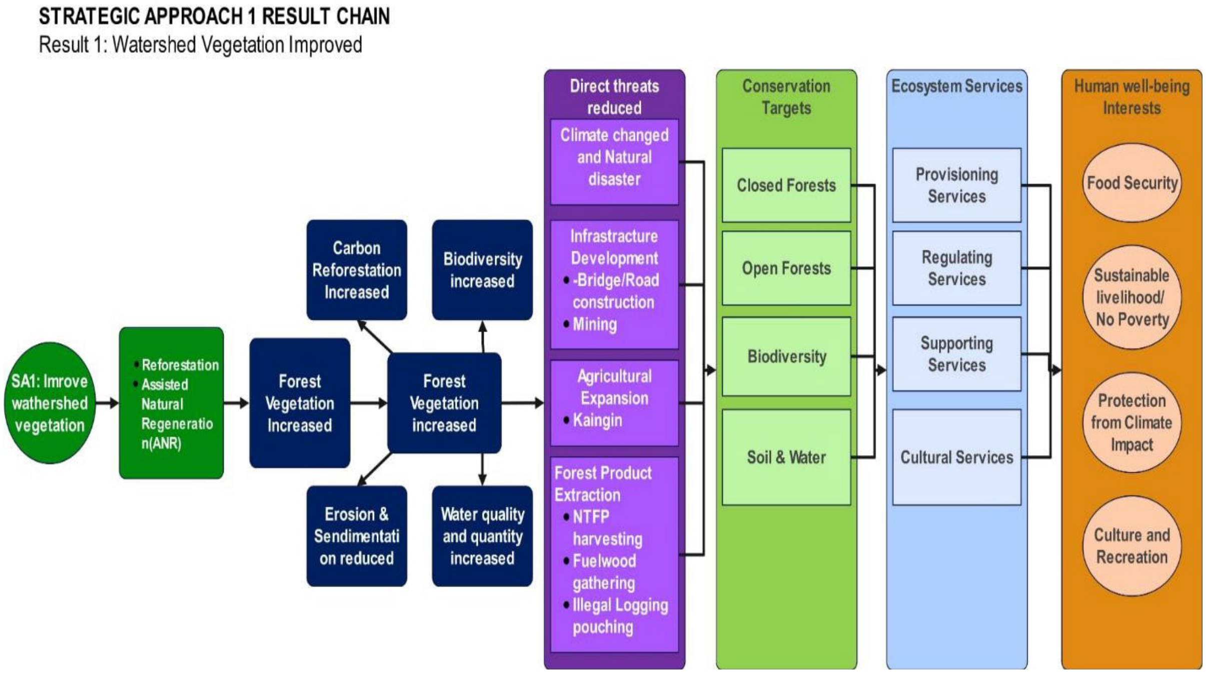

Figure 7. Strategic Approach 1.

Theory of Change Narrative. If restoring the watershed functions to optimum levels through a revegetation strategy, then it can reduce direct threats to climate change impacts since it will contribute to climate regulations such as temperature, carbon sequestration, water cycle stabilization, soil protection, and biodiversity support. Also, it will lessen infrastructure development, particularly on soil and water conservation, provide alternative livelihoods, community awareness, and strengthen land tenure by tree planting, since this activity can help determine the land ownership, lessening open access to kangin-making. Lastly, improving forest vegetation improves law enforcement and monitoring through actively implementing rules and regulations, contributing to less illegal forest extraction. This enhances the resilience and functionality of watersheds, providing a foundation for sustainable environmental management and long-term ecological stability and human well-being.

Description of Activities. The project to bring back the vegetation of the watershed will be a series of interrelated activities with the goal of restoring the watershed functions to an optimum level through revegetation strategies. The areas that need to be revegetated in the watershed, with their timeline of implementation, are shown in **Table 13**. The key activities for reforestation and Assisted Natural Regeneration are presented in **Table 14**.

Table 13. Timeline for reforestation over the planning period of 2023-2040 (in hectares).

Indicator	2023 (Baseline)	2024–2030	2031–2040 Full Development
A. Rehabilitation of open forests and regenerating vegetation to closed forests			
Natural Regeneration/Assisted Natural Regeneration	995	2583	No further targets
Closed Forest	25,957	26,952	40,038
Open Forest	12,493	11,498	No further targets
Other vegetation	1588	1588	No further targets
B. Forests in A&D lands are protected from conversion to other land uses			
Forest in A&D	305	305	305
Total	27,670	40,665	61,851

Source: Conner Watershed Management Plan.

Table 14. Key activities of Reforestation and Assisted Natural Regeneration (ANR).

Key Activities	
Reforestation	Site selection, participatory surveying, and mapping
	Agreement on reforestation approach and species to be used
	Nursery operations of suitable species
	Site preparation development
	Maintenance and protection
Assisted Natural Regeneration (ANR)	Site selection, surveying, and mapping with community members
	Training on Assisted Natural Regeneration
	Purchase of indigenous seedlings
	Enrichment planting
	Fireline establishment and maintenance (1000 sqm of fireline/ha, and reweeded 8 times within 3 years
	Ring weeding of at least 800 regenerants, and
	Replanting activities

3.3.3. Strategic Approach 2: Provide Alternative Livelihood

This approach aims to reduce reliance on environmentally damaging practices while improving economic opportunities for local communities. Alternative livelihood projects have been widely employed to reduce environmental threats, but evidence of their effectiveness varies, with only a subset reporting positive outcomes in behaviour change or conservation status improvements [30].

In this study, Agroforestry is supported to increase the household income of PO members while increasing forest cover with a combination of market-oriented short, medium, and long-term agroforestry crops that could be mixed with annual, high-value fruits, perennials, and tree species. In addition, the development and promotion of potential eco-tourism sites and Non-timber Forest Products (NTFP) processing and development will be considered.

Key Results and Outcomes. **Figure 8** provides key results and activities to be implemented to achieve deliverables that will contribute to desired outcomes under SA 2. Agroforestry development, promotion and development of eco-tourism sites, and the processing and development of Non-timber Forest Products serve as interventions for alternative livelihoods. These livelihoods exhibit potential intermediate results, such as a) if trees are combined with crops or livestock, it reduces the vulnerability of farmers to climate shocks; b) improved market accessibility; c) opportunity for value- adding through processing of products that may create additional income streams; d) skills development; and e) transportation and support services increased. All these intermediate results are expected to contribute to the economic well-being of the communities within the watershed.

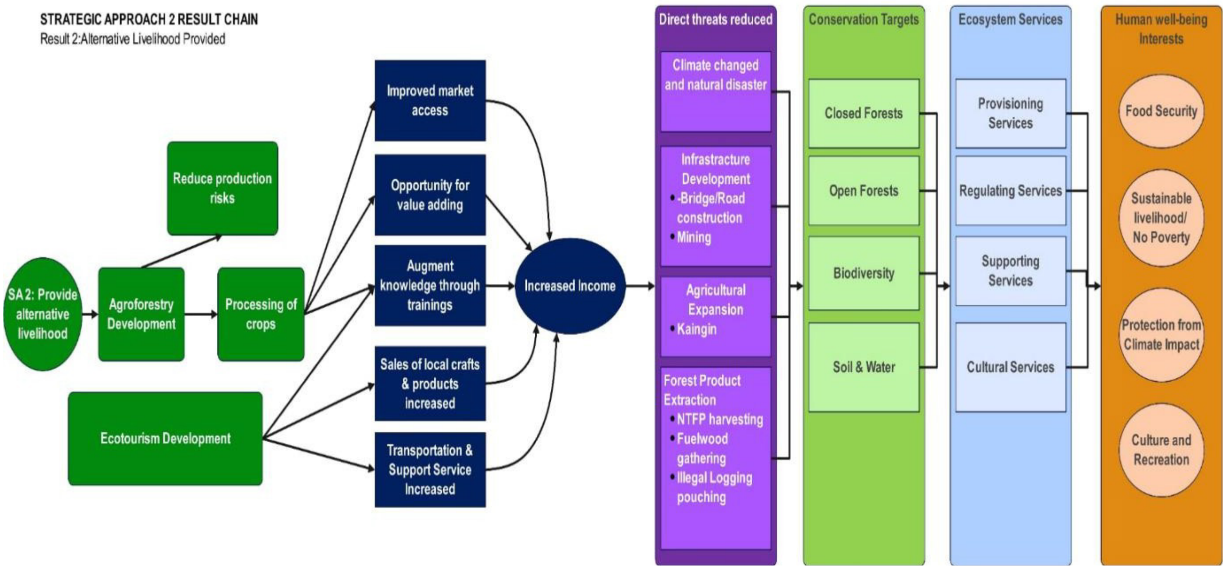

Figure 8. Strategic Approach 2.

Theory of Change Narrative. If the community within the watershed is provided with alternative livelihoods as an additional source of income, then alternatives can help diversify income sources, reduce dependency on resource-depleting activities, thereby improving overall economic stability, environmental sustainability, and improve quality of life.

Description of Activities. The activities to be undertaken in this strategy approach are the following: Orient and conduct community mapping to validate potential sites; determine appropriate mix of market-oriented agroforestry species with short one (one year), medium (between 2–5 years), and long term (more than 5 years) economic benefits from cash crops, fruit trees, forest species, livestock, and other products; conduct consultation and support the POs to solicit commitments of willing PO members as participants with menu of potential short, medium, and long term agroforestry species; facilitate agreement with the PO especially on the choice of the of a mixture of agroforestry species, criteria for selecting participants for PO members, implementation strategies and arrangement, counterpart requirements, and M&E system; facilitate participatory conduct of delineation, survey, and community mapping to identify individual claims, assist POs to coordinate procurement, distribution, planting, and monitoring agroforestry development in individual HH farms, assist farmers in developing their agroforestry farms including procurement of planting materials and linking them with the market or supply raw materials for processing, and provide extension and capacity building support for IPOs or POs and participating members.

The target areas for agroforestry development are those in production forests, multiple-use zones of protected areas, and appropriate zones in ancestral domains. The area that is potentially for Agroforestry to be developed by the year 2040 is 251,501 hectares.

In terms of eco-tourism, there will be a conduct of tourism investment promotion and marketing to develop the ecotourism sites of the municipality in partnership with the private sector, develop eco-tourism products for promotion and marketing, establish a tourism center, and conduct capacity building for POs involved in ecotourism livelihood.

In addition, alternative livelihoods given to the POs consist mainly of the production of sugarcane, pepper, and bignay, which are the kinds of livelihoods that the POs are familiar with. The funds provided have been used for the purchase of equipment and facilities needed for the simple processing of farm produce, such as a sugarcane crusher and a multipurpose processing center.

3.3.4. Strategic Approach 3: Improve Information, Education, and Communication

To improve the level of awareness and understanding of the communities, even among the local government units, about the ecological functions of the watershed, plus the lack of an IEC program specifically on watershed conservation and protection, it is imperative to have an intensive IEC campaign program.

Information, Education, and Communication (IEC) is crucial for effectively managing watershed areas and promoting sustainable practices. IEC strategies aim to enhance understanding, raise awareness, and facilitate the adoption of best practices among stakeholders. By developing targeted materials, enhancing public engagement, leveraging technology, building partnerships, and continuously evaluating efforts, stakeholders can foster better understanding and adoption of sustainable practices. These strategies help ensure that watershed management initiatives are well-supported and effectively contribute to environmental conservation and community resilience.

Key Results and Outcomes. **Figure 9** provides key results and activities to be implemented to achieve deliverables that will contribute to desired outcomes under SA 3. Identified interventions are the conduct of a situational analysis to improve understanding of the current situation of the watershed, and carry out community awareness through various media to improve knowledge on sustainable practices and relevant laws, and to have a higher participation in local watershed activities, thus contributing to a more positive attitude towards conservation and protection of the watershed.

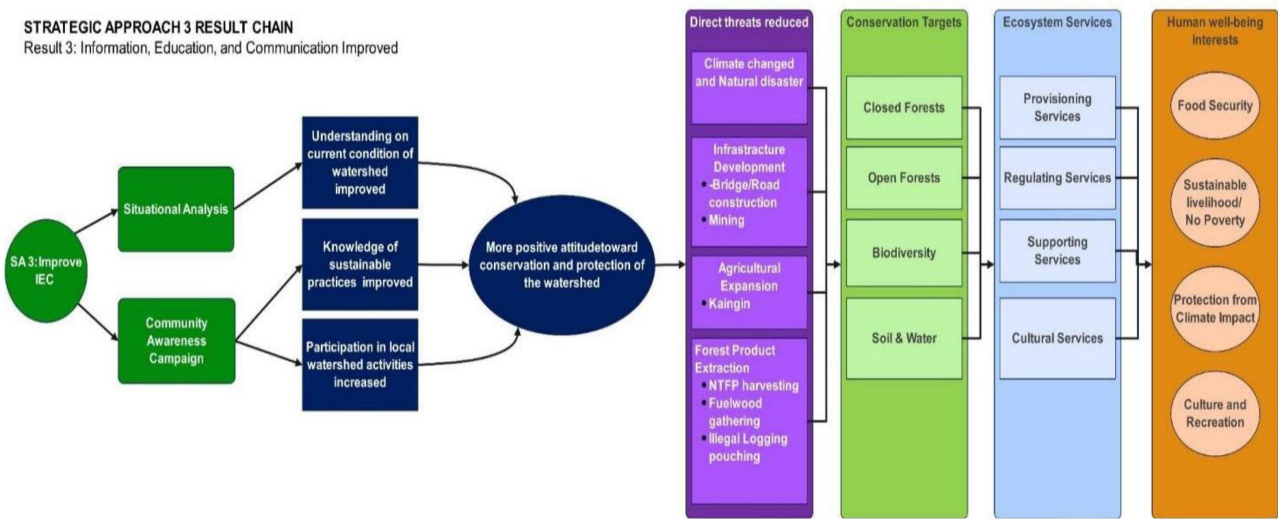

Figure 9. Strategic Approach 3.

Theory of Change Narrative. If communities are informed and educated about the importance of the watershed in terms of ecosystem services that it provides and understand the critical issues associated with poor watershed management, then they become more engaged, adopt sustainable practices, and advocate for effective policies. This leads to enhanced ecosystem health, improved resilience, and significant economic, social, and cultural benefits. Also, communities contribute to the long-term sustainability and prosperity of their natural resources and well-being.

Description of Activities. The IEC aims to create public awareness of the programs and projects to be implemented in the watershed. The intended audiences are local people, LGUs, NGOs, the Business sector, Academe, teachers, students, and the general public. Issues and concerns are focus on concept of watershed and community-based watershed management, functions and economic benefit of the watershed, soil and water conservation measures and environmental protection, livelihood and technologies to advocate to rehabilitate agroforestry, sustainable agriculture, and integrated farming system, and roles and participation of the local constituents, local leaders, and institution, in the protection and conservation of the watershed.

The activities are focused on the following: conduct of situational analysis, taking into consideration the existing awareness, knowledge, attitude, or perception and practices of various audiences, assessment of existing communication resources, and training needs. Implement IEC approaches through radio broadcast, IEC materials (leaflets, pamphlets), online platforms, and interpersonal IEC approaches.

3.3.5. Strategic Approach 4: Enhance Capacity for Entities Responsible for the Enforcement of Forestry and Environmental Laws and Regulations

Enhancing the capacity for law enforcement in watershed management involves a multifaceted approach, including training, resource allocation, legal framework improvement, and collaboration. By investing in these areas, authorities can more effectively enforce environmental regulations, protect watershed health, and ensure sustainable management of water resources. This, in turn, contributes to the overall health of ecosystems and the well-being of communities reliant on these vital resources.

Key Results and Outcomes. **Figure 10** provides key results and activities to be implemented to achieve deliverables that will contribute to desired outcomes under SA 4.

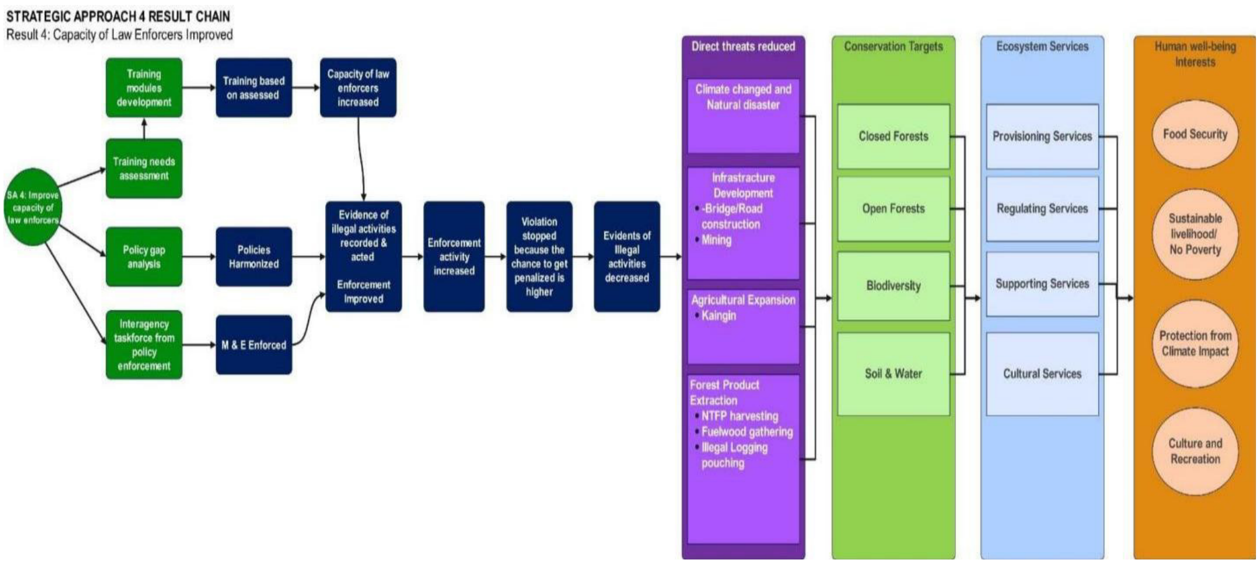

Figure 10. Strategic Approach 4.

Theory of Change Narrative. If the Watershed Protection Group (WPG) and Multi-sectoral Watershed protection Committee (MWPC) are equipped with training and skills enhancement to enforce and monitor forestry and environmental laws and regulations. Then, enforcement of forestry and environmental laws, strengthened and improved coordination among stakeholders, will result in increased public awareness, more effective conservation measures, and better policy advocacy. Thereby, contributing to healthier and more resilient watershed ecosystems, ensuring sustainable management and protection of natural resources.

Description of Activities. In addition to the IEC programs, which will primarily focus on educating the public about all relevant laws and regulations, the following activities will be introduced: an assessment of the capacities of the Watershed Protection Group (WPG) and other concerned stakeholders, including DENR, LGUs, NGOs, Academia, and Local Communities. This will entail the crafting of training modules based on assessment results and will be used during the capacity building. This will build their practical skills, especially for the local communities. Another activity is conducting policy gap analyses to identify inconsistencies, missing elements of existing policies, areas for improvement, and supporting policy harmonization related to the implementation of policies or local ordinances related to the conservation and protection of watersheds or natural resources. Strengthening institutional coordination by developing inter-agency task forces for joint policy enforcement, enforcing a monitoring and evaluation system by documenting the operations that will be conducted, the number of apprehended, and cases filed, and conducting regular assessments and feedback sessions to improve enforcement practices.

3.3.6. Strategic Approach 5: Improve Social and Human Capital Development

Social and human capital development in the context of watershed management refers to enhancing the skills, knowledge, networks, and community engagement that contribute to effective watershed protection and sustainable resource management. Building social and human capital is essential for fostering local stewardship, promoting sustainable practices, and addressing watershed challenges collaboratively. This approach not only helps in protecting and restoring watershed health but also fosters resilience, sustainability, and long-term success in managing natural resources.

Key Results and Outcomes. **Figure 11** provides key results and activities to be implemented to achieve deliverables that will contribute to desired outcomes under SA 5, which is active POs ensuring that watershed management is participatory, responsive, and effective.

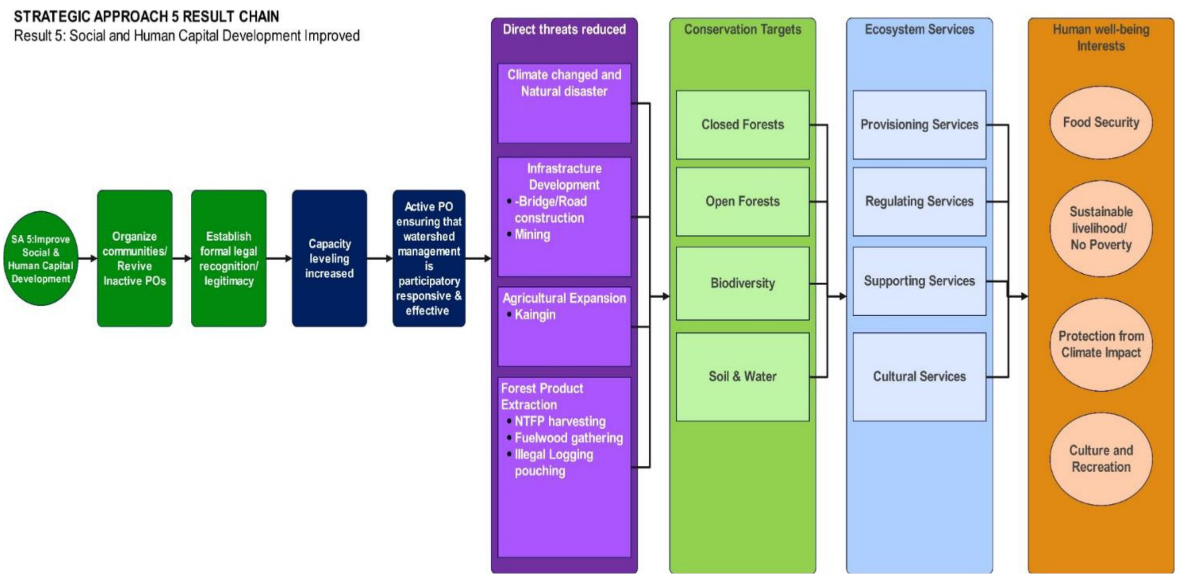

Figure 11. Strategic Approach 5.

Theory of Change Narrative. If social and human capital development is enhanced through community organizing and the provision of training. Then, it will lead to greater community engagement, enhanced knowledge and skills, and stronger local institutions. These improvements will support sustainable livelihoods, better resource management, and effective conservation practices. Thereby, contribute to more resilient and adaptive watershed management, ensuring the long-term health and sustainability of watershed ecosystems.

Description of Activities. Organize communities or revive inactive people's organizations, register people's organizations with the SEC or DOLE for formal legal recognition and legitimacy; Conduct community organizing to function more efficiently and more effectively in pursuing collective goals, and establish a formal and legal identity to be able to transact business for their projects. Strengthen CSO through capability-building programs and attendance in conferences on social and technical aspects of watershed management. In addition, strengthening of local governance through training in terms of accountability, participation, transparency, and predictability, formulation of policies, crafting management plans, as well as implementation, monitoring & evaluation of plans.

3.3.7. Strategic Approach 6: Enhance Research and Technology Development

Enhancing research and technology development in watershed management leads to improved data collection, more accurate modeling and forecasting, and innovative conservation technologies. These advancements support sustainable resource management, effective restoration efforts, and increased community engagement. Additionally, research and technological innovations contribute to better policy development, governance, and climate resilience. Overall, these improvements help ensure the long- term health and sustainability of watershed ecosystems.

Key Results and Outcomes. **Figure 12** provides key results and activities to be implemented to achieve deliverables that will contribute to desired outcomes under SA 6.

Theory of Change Narrative. If academic institutions enhanced their capacity to conduct research and technology development in the context of watershed management. Then, there is the availability of tools and knowledge needed to monitor and understand watershed dynamics, develop innovative conservation strategies, and optimize resource management. Thereby, this leads to a larger pool of experts, accurate monitoring, effective conservation practices, and sustainable resource use. Additionally, it strengthens community engagement, supports informed policy development, and increases resilience to climate change, ultimately contributing to the overall health and sustainability of watershed ecosystems.

Description of Activities. Conduct baseline and diagnostic studies or validate the current results of the existing conditions of the watershed as a scientific basis for planning and interventions; establish a watershed knowledge database for institutional knowledge and support learning; conduct research and innovation related to watershed management like resource pricing methods or payment of ecosystem services; disseminate research findings for policy adaptation, and adapt research based technology for watershed management, protection and conservation such as soil and water conservation and other technologies.

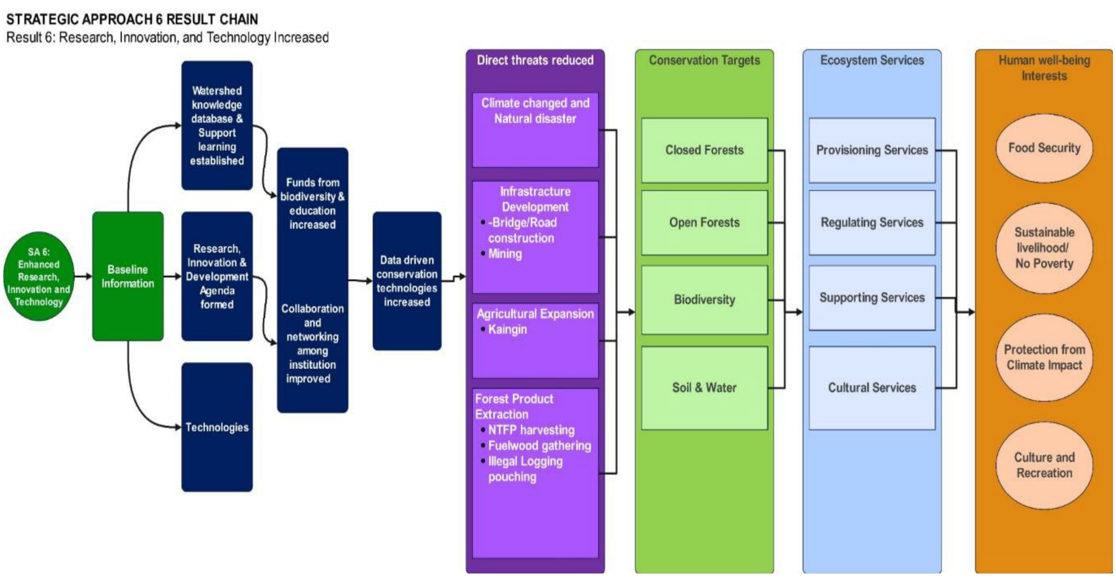

Figure 12. Strategic Approach 6.

4. Conclusion and Recommendations

4.1. Conclusion

The study concludes that the long-term sustainability of ecosystem services in the Conner Watershed depends greatly on effective protection, management, and restoration efforts. Although the watershed continues to provide vital ecological functions, signs of forest disturbance indicate increasing vulnerability to degradation if destructive land-use practices persist. The identified drivers of change—such as deforestation, agricultural expansion, and inadequate resource governance—highlight the urgent need for integrated and participatory watershed management.

The proposed Theory of Change framework offers a strategic pathway for achieving both ecological integrity and human well-being. Linking the six strategic approaches into a coherent plan of action provides a clear direction for restoring degraded areas, strengthening community capacity, and ensuring that ecosystem services remain sustainable for present and future generations. Ultimately, the conservation and proper management of the Conner Watershed are imperative for maintaining ecological balance, supporting livelihoods, and promoting climate resilience across the region.

4.2. Recommendations

1. It is recommended to implement the targets outlined in the Conner Watershed Plan to prevent soil erosion, floods, and landslides, thereby protecting the ecosystem and supporting sustainable land use.
2. It is recommended to implement forest conservation and reforestation programs in the Conner Watershed to protect economically valuable Dipterocarp species. Measures should include controlling illegal clearing, promoting sustainable farming practices, and restoring partly disturbed areas to improve biodiversity.
3. It is recommended to adopt and implement the strategic approaches outlined in the Theory of Change to ensure the sustainability of ecosystem services, thereby enhancing both human and ecological well-being in the Conner Watershed.

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Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

All data generated in the course of this study are available in this article.

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Conflicts of Interest

The author declares no conflict of interest.

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