Institutional Mapping of Adaptation Options in Malwathu Oya, Yan Oya and Mi Oya River Basins in Sri Lanka

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Summary

This report examines the nature of polycentric governance and transformative characteristics adaptation options in Sri Lanka. The report focuses on four major climate adaptation projects implemented in recent years, namely Climate Resilient Integrated Water Management Project (CRIWMP), Climate Resilience Improvement Project (CRIP), Climate Smart Irrigation Agriculture Project (CSIAP), and the Northwestern Province Canal Project (NWPCP). The analysis includes institutional mapping of the four projects and an assessment of the extent of polycentric governance and transformational characteristics of three specific transformational adaptation options, namely 1). Forming Cascade management committees and strengthening farmer organizations, 2). Diversification of high-value crops, climate-smart water management, and agricultural practices, and 3). Basin investment planning accounting climate change risks. The analysis found that the national-level ministries and departments dominate the planning and implementation of interventions. The methods and the extent of inputs from local and community-level institutions and farmers can be substantially improved in the planning and implementing adaptation projects. Although the adaptation interventions within the three projects have some transformational characteristics, they can be enhanced with other transformational characteristics and polycentric governance to ensure systemic changes in the socio-ecological system to address the increasing challenges of climate change.

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List of Abbreviations

ADB	Asian Development Bank
CMC	Cascade Management Committee
CKDu	Chronic Kidney disease of unknown etiology
CRIP	Climate Resilience Improvement Project
CRIWMP	Climate Resilience Integrated Water Management Project
CSIAP	Climate Smart Irrigated Agriculture Project
CBOs	Community-Based Organizations
DAD	Department of Agrarian Development
DNCWS	Department of National Community Water Supply
DS	Divisional Secretary
FOs	Farmer Organizations
GOS	Government of Sri Lanka
GN	Grama Niladhari
GCF	Green Climate Fund (GCF)
ID	Irrigation Department
MWSIP	Mahaweli Water Security Investment Programme
MOA	Ministry of Agriculture
M&E	monitoring and evaluation
NWSDB	National Water Supply and Drainage Board
NWPCP	Northwestern Province Canal Project
TAOs	Transformative adaptation options
UNDP	United Nations Development Program

.

1. Introduction

Sri Lanka, an Island Nation in the Indian Ocean, has high climate risk. The Global Climate Risk Index ranked Sri Lanka as the 30th highest climate-risk country in 2021 and the 3rd highest in 2017 (Eckstein et al., 2017, 2021). Floods, droughts, storms, and landslides are recurrent disasters. Between 2000 and 2022, 50 floods, five droughts, and 15 storms affected over 16 million people and USD three billion in damages (EM-DAT 2020). Short to long-term economic losses are significantly more.

The most vulnerable to climate hazards are the rural people and their livelihoods. Seventy percent of the 22 million Sri Lankan population are still rural. Of this, 30% of the livelihood is based directly on agriculture. Backward and forward linkages provide indirect benefits to many more. The drought that started in August 2016 has made life miserable across the island and affected more than 900,000 people by May 2017 (DMC 2017). It disrupted water supplies, agriculture, coastal zones, human health, and flora and fauna in many areas. The losses experienced from the 2016-17 droughts were among the most catastrophic in recent decades. The paddy production in the Maha, or the primary season, has dropped by 50% relative to the harvest in the previous three seasons.

Floods and droughts have substantial social and economic impacts, too. The loss of income was the main financial cost of the dry-zone farmers. The dry zone, which contains two-thirds of the land area, contributes most to food production. Household food insecurity, increased food expenditure, and slowing economic growth are other direct impacts of droughts. Indirect effects are the increase in cost related to water-related health issues. Floods lead to the destruction of irrigation infrastructure and crop damage from inundation.

Irrigation provides resilience to agriculture from climate variability and extremes. Government institutions manage the major and medium irrigation systems, classified as those with command areas over 80 ha. Many major irrigation systems benefit from trans-basin diversions, which induces additional climate resilience. However, recent changes in monsoonal rainfall patterns also increase their vulnerability. The minor tank irrigation and rainfed areas, whose primary water source is local rainfall, contribute to 47% of the total rice area and 42% of the production. The high rainfall variability affects minor tank irrigation and rainfed systems the most.

Farmer communities, with limited government support, generally manage small tank irrigation systems. Many of the 14,000 plus small tanks are in about 70 river basins out of the 103 river basins in Sri Lanka (Panabokke et al., 2002). Tank-cascades, a unique feature in minor tank irrigation, comprise a hydrologically connected series of tanks and diversions (Anicuts). Overall, about 67% of small tanks are in cascades. Dharmasena (2020) describes them as “An ecosystem, where water and land resources are organized within the micro-catchments of the dry zone landscape, providing basic needs to human, floral and faunal communities through water, soil, air, and vegetation with human intervention on a sustainable basis.” If scientifically managed, this hydrological connectivity can mitigate the effects of floods and droughts. Small tanks also cater to multiple water uses in a village, including domestic, livestock, and agricultural needs. These characteristics make the management and governance in minor tank irrigation different from those of major irrigation.

With increasing climate risks, the Sri Lankan government, with international donors' aid, implemented many adaptation interventions in irrigated agriculture in recent years. The Green Climate Fund (GCF)

provided US$ 38 million for the Climate Resilient Integrated Water Management Project (CRIWMP) from 2017-2024 (GCF, 2016). The World Bank invested US$ 110 million for the Climate Resilience Improvement Project (CRIP) and another US$ 125 million for the Climate Smart Irrigated Agriculture Project (World Bank, 2019). The Asian Development Bank (ADB), according to the initial estimates, planned to invest US$ 30 million in the Northwestern Province Canal Project (NWPCP).

Do these adaptation interventions have polycentric governance? In the absence, most institutions at various scales and sectors likely work in silos, organize loosely, and do not take into consideration others' interests and functions. According to Ostrom (2010), multiscale polycentric governance comprises a self-organizing system with many autonomous units, which are formally independent but work in consideration of others and through competition, cooperation, and conflict resolution. Interventions without polycentric governance will likely have less than the ideal performance and impacts.

Are these adaptation interventions transformative? Many of the adaptation interventions in the past, with or without polycentric governance, resulted in incremental benefits. After a few years, systems with incremental benefits will be in the same dilapidated state, requiring further interventions to address similar or new issues. Transformative adaptation could address these issues and instill a systemic change in the functioning of systems. According to Fedele et al. (2019), transformative adaptation could have several characteristics contributing to this systemic change. Interventions with restructuring, path shifting, multi-scale, innovative, persistent, and system-wide characteristics will likely have sustainable impacts and outcomes.

This paper assesses the polycentric governance and transformative nature of recent large-scale adaptation interventions in Sri Lanka. The strengths and gaps of these interventions' governance will help identify a framework for multiscale polycentric governance for transformative adaptation. This paper focused on three basins: the Malwathu, Yan, and Mi Oya basins in the Northcentral and Northwestern provinces, where the Government of Sri Lanka (GOSL) implemented several large-scale adaptation interventions in the last decade. These three basins, particularly those in the dry zone consisting of north-western, north central, and northern, and eastern regions in general, face the brunt of the impacts of climate variability (Amarasinghe et al., 2020).

To understand the nature of polycentric governance, mapping institutions involved in adaptation interventions is necessary. The interventions for institutional mapping of focus in this paper are 1) Climate Resilience Integrated Water Management Project (CRIWMP), 2). Climate Resilience Improvement Project (CRIP), 3). Climate Smart Irrigated Agriculture Project (CSIAP), and 4). The Northwestern Province Canal Project (NWPCP). The primary objectives of CRIWMP, CSIAP, and NWPCP are managing water in the small tank irrigation systems to enhance resilience. A significant focus of CRIP is on the major and medium irrigation systems.

The paper has the following outline. Section 1 examines the need for transformative adaptation and polycentric governance in Sri Lanka's irrigated agriculture. Section 2 briefly describes polycentric governance and transformative adaptation in Sri Lanka. Section 3 shows the assessment methodology. Section 4 shows the institutional mapping for the four interventions. Section 5 discusses the polycentric and transformative elements of adaptation interventions, their adequacy, and the barriers to improved adaptation and governance.

1.1. Polycentric Governance and Transformative Adaptation in the Context of Climate Resilience in Sri Lanka

1.1.1 Transformative Adaptation

Fedele et al. (2019) discussed the responses of social and ecological systems to the adverse impacts of climate change. They categorized the responses into three major types: coping responses, incremental adaptation, and transformative adaptation.

- Coping strategies are strategies that people use to resist the impacts of climate change and maintain the affected social-ecological system in a similar state or business-as-usual functioning.
- Incremental adaptation includes strategies to continue to provide benefits by accommodating changes. Incremental adaptation strategies drive minor and small-scale adjustments to current social-ecological systems and focus on building resilience to climate change impacts. Incremental adaptation modifies the social or ecological system to accommodate changes. Still, it does not alter the fundamental characteristics of the social-ecological system so that people may remain vulnerable to future floods.

Conventional coping strategies and incremental adaptation to climate change may not always be effective at helping people or ecosystems reduce their vulnerabilities to severe climatic changes. Transformative adaptation options refer to these changes that fundamentally focus on the entire system's ecological and social properties and functions. It aims to reduce the root causes of vulnerabilities to climate change. In Sri Lanka's irrigation systems, one may find instances of all three types of responses.

Often, coping strategies or incremental adaptation are the responses in minor (small tank) irrigation systems to address the impacts of climate variability and extremes. When a tank is breached, and there are no resources to repair it, some farmers build small diversion structures and cultivate a smaller area. Some farmers shift to rain-fed cultivation, while others divert to different livelihoods. Government institutions or NGOs often repair the damages, but the structures remain vulnerable to large floods. Moreover, field inspections showed inadequate maintenance of structures and the associated ecosystem, which is a major cause for structures to deteriorate prematurely, and physical improvements alone would not sustain the tank operations. Therefore, small tank irrigation systems need transformative adaptation strategies to address the root causes of failures and have a systemic change to face increasing climate change impacts.

The focus of major irrigation systems is increasing agriculture production for national food security. Therefore, the government's investments in human and financial resources for operation and maintenance are comparatively higher. However, they are also threatened by climate variability, especially flash floods and prolonged droughts. A transformative adaptation strategy, including river basin-level planning focusing on climate risk, must address these new issues.

Fedele et al. (2019) identified six characteristics of transformative adaptation:

1. Restructuring: Resulting in significant shifts in fundamental properties, functions, or interactions within the system
2. Path-shifting: Resulting in changes to the systems' current trajectory.
3. Innovative: Changing the system to a new state through introducing knowledge, policies, or technologies
4. Multi-scale: Impacting across multiple scales, such as trophic, spatial, jurisdictional, or sectoral scales.
5. System-wide: Leading to systemic changes across whole regions, ecosystems, landscapes, or communities.

- Persistent: resulting in shifts with long-term but not necessarily irreversible impacts,

We shall be guided by the above characteristics in analyzing the adequacy of the transformative nature of the interventions.

1.1.2 The relevance of polycentric governance

Morrison et al. (2019) discussed the differences between monocentric and polycentric governance systems. A governance system controlled by a government authority or a private monopoly responsible for all goods and services is an example of a monocentric governance system. A polycentric system engages multiple governing authorities that do not possess a hierarchical relationship to each other. These authorities may operate at different scales while making mutual adjustments.

In the case of Si Lanka, the major irrigation systems managed by the Mahaweli Authority of Sri Lanka are close to having monocentric governance due to the powers vested on that institution by the Mahaweli Authority of Sri Lanka Act of 1979. The major irrigation systems managed by the Irrigation Department are between these two systems. The Department has the power to effect structural improvements, water management, and the engagement of farmer organizations. At the same time, other government institutions handle the services related to agriculture and land-related issues.

However, the situation is more complex in the case of minor Tank irrigation. These are theoretically farmer-managed irrigation systems. Since the 1950s, these systems came under the purview of the Department of Agrarian Development. The 13th amendment to the constitution of Sri Lanka, enacted in 1987, brought irrigation other than inter-provincial irrigation projects under the provincial councils. Accordingly, the provincial councils have the authority to make laws regarding these irrigation systems by passing statutes subjected to the relevant national policy (Nanayakkara, 2017). However, the scope of the statutes related to minor Tank irrigation can change from one province to another, and the responsibility of subjects such as water management remains vague. While the farmer organizations come under the purview of the Department of Agrarian Development (DAD) under the central government, the Provincial Councils provide agriculture extension services.

Another issue is the non-inclusiveness and the lack of integration among various community groups in the institutional setup. The traditional small tank irrigation served multiple uses, and the village life depended on the complementary services of rain-fed and irrigated agriculture. The Farmer Organization system focuses on the irrigated command area, and there are different community organizations under various

government institutions for fisheries in the Tank and drinking water services. The current institutional setup provides little opportunity for women and youth to manage water and associated resources at the village and cascade levels.

Oberlack et al. (2018) note that "governance systems are polycentric if they involve multiple arenas of decision making, which operate with some degree of autonomy but are interlinked through processes of cooperation, coordination, or conflict." Therefore, a polycentric approach helps design sustainable transformations through stakeholder engagement. In such situations, isolated decision-making, for example, by the central government or local communities, can fail. Many small-scale social-ecological systems that previously depended on internal feedback between their social and ecological sub-systems are now connected outside such local domains. These new interactions outside the local domain significantly challenge land governance and the system's sustainability. New trade-offs between ecosystem services and sustainability goals, conflicts of interest between resource users, and competition for natural resources require decisions on priorities assigned to different sustainability values and resource claims.

The above statements are relevant to the management and governance of Sri Lankan irrigation systems. Small tank irrigation systems, from ancient times, were isolated and self-sufficient and mainly depended on local resources. This characteristic enabled them to survive several thousands of years despite political turmoil and changes in government policies. However, the socio-economic environment has drastically changed now. Abolition or non-functioning of "Rajakariya" (service to the king) and caste system, dependence on the central economic centers, competition for water from non-agricultural sectors, population increase, etc., have made the operation and maintenance of irrigation systems complex, the profitability of agriculture low, and pollution levels of water bodies high. Moreover, human-wild animal conflicts affect the farmer community, and they need the support of institutions such as the Forest Department and the Department of Wildlife Conservation to maintain life and livelihoods.

A polycentric governance system can be a remedy for this confusing state. Such a system can bring government institutions and community groups into a common forum and enable optimum utilization of local resources.

1.2 Climatic Variability and Adaptation Interventions

Sri Lanka has three agro-climatic regions with highly variable rainfall patterns (Figure 1). Monsoonal weather determines the rainfall in different regions. Both the monsoons, the southwest (between May and September) and northeast monsoons (between October and April), bring substantial rainfall to the Wet Zone (Table 1), which primarily comprises the western, central, and southwestern parts of the country. The Dry Zone, comprising mainly the northern, north central, and eastern districts, and the Hambantota district in the south, receives much of its rainfall from the northeast monsoon.

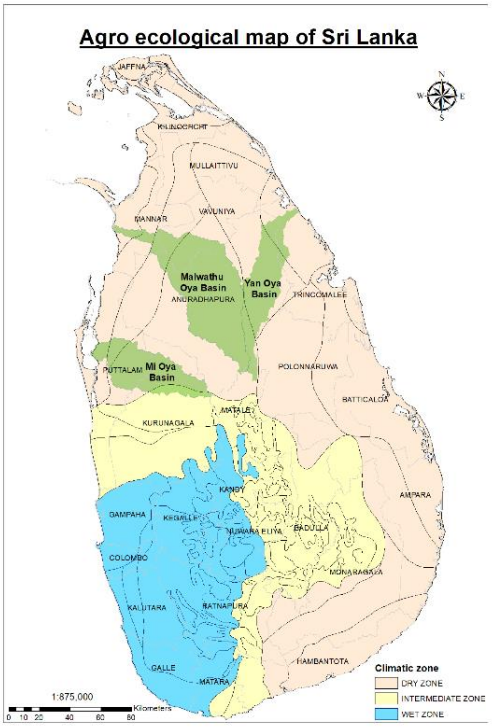


Figure 1A. Agro-ecological regions of Sri Lanka

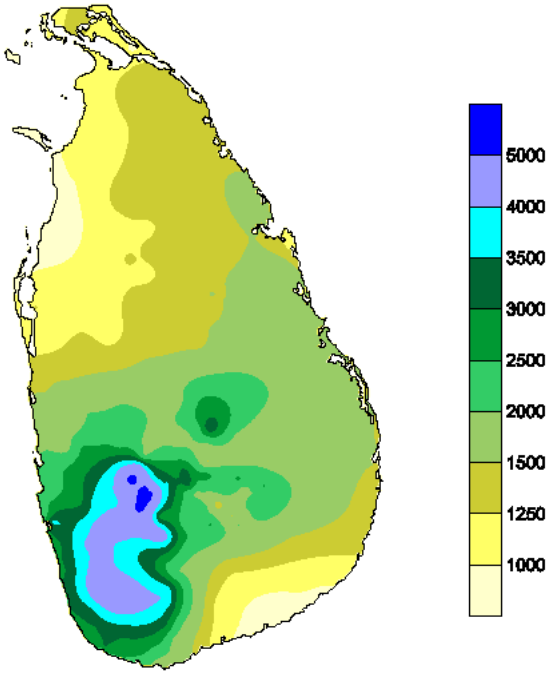


Figure 1B. Rainfall variability across agro-ecological regions

Figure 1: Annual Rainfall Distribution in Sri Lanka

Source: Authors and Source: Department of Meteorology
http://www.meteo.gov.lk/index.php?option=com_content&view=article&id=94&Itemid=310&lang=en

Table 1: Average rainfall between 1971 and 2015

Climatic zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Maha season	Yala season
Wet-zone	110	99	154	277	315	258	192	179	266	369	355	210	1210	1569
Intermediate	138	88	103	189	110	54	55	57	103	255	305	240	379	1311
Dry-zone	94	63	51	93	66	22	33	39	77	200	281	257	237	1035
Sri Lanka	114	83	97	174	162	112	94	92	149	269	312	244	609	1289

Source: District rainfall data from the Department of Meteorology

Notes- 1- The wet-zone average is based on the rainfall of districts of Colombo, Gampaha, Kalutara, Kandy, Nuwara Eliya, Matale, Kegalle, and Rathnapura
2- The intermediate zone average is based on Kurunegala, Badulla, and Monaragala
3- The dry-zone average is based on Hambantota, Ampara, Batticaloa, Trincomalee, Jaffna, Kilinochchi, Manner, Mullaitivu, Vavuniya, Anuradhapura, and Polonnaruwa

The Malwathu Oya and Yan Oya, two River basins of focus in this analysis, have high vulnerability and increased exposure to climate change (Amarasinghe et al., 2020). The Mi Oya, the other River Basin of

focus, has high exposure but medium vulnerability. All three river basins have medium adaptive capacity. The vulnerability of these River basins is due to their substantially higher tank (village) irrigation and rainfed systems (Table 2). Minor irrigation systems take up 58% of the total paddy irrigated area, and along with rainfed paddy, they take up 63% of the total paddy area. For water resources, these systems depend primarily on rainfall. A 93% of the total population living in rural areas depend their livelihoods on agricultural-related activities.

Table 2 : Agriculture in the Malwathu, Mi, and Yan Oya River Basins in 2021

Variable	Malwathu Oya	Mi Oya	Yan Oya	Sri Lanka
Land area (ha)	286,052	147,296	155,490	6,560,950
Population (Thousands)	400	197	134	22,156
Rural Populations (Thousands)	349	190	134	17,159
Agriculture area (ha)	91,294	54,094	54,792	2,098,490
Paddy area (Ha)	46,597	23,103	31,612	947,458
Paddy Irrigated area (Ha)	41,092	20,227	25,836	973,338
• Major/medium systems	17,763	9,319	10,218	653,582
• Tank systems	23,329	10,908	15,618	319,756
Rainfed paddy area	5,505	2,876	5,776	203,415

Source: Authors based on data from the Census and Statistics 2023

These three basins are among the country's 20 most important river basins for irrigated agriculture (Infotechs IDEAS, 2022). Without adequate water storage in tanks and reservoirs, much of the Yala season (from April to August) agriculture would not be possible in these river basins. Therefore, enhancing the storage of small tanks, improving water management, inter-basin diversions of water, and climate-smart agriculture are some adaptation options for increased rainfall variability. Rehabilitation of village irrigation systems, i.e., small tanks or tank cascades, augmenting water supply to irrigation reservoirs, flood and drought management, and climate-smart agriculture, is the major activities proposed under the three adaptation interventions CRIWMP, CRIP, and CSIAP.

The **CRIWMP** adaptation intervention, funded by the Global Climate Fund (GCF), aimed to strengthen the resilience of smallholder farmers, particularly women, in the Dry Zone. CRIWMP uses an integrated approach for improved water management to enhance lives and livelihoods. The project has three major components: upgrading village irrigation systems and scaling up climate-smart agricultural practices; enhancing decentralized water supply and management solutions to provide safe drinking water to vulnerable communities; and strengthening early warning, forecasting, and water management systems to enhance the adaptive capacity of smallholder farmers to droughts and floods. The Yan Oya, Malwathu Oya, and Mi Oya were the river basins focused on by the CRIWMP. The safe drinking water supply was targeted in the Anuradhapura, Polonnaruwa, Mannar, Vavuniya, Trincomalee, Kurunegala, and Puttalam districts.

The **CRIP** adaptation intervention, funded by the World Bank, aimed to enhance early warning needs and flood management in some vital river basins. The critical components of CRIP were developing the basin investment plans, increasing climate resilience of infrastructure, and contingent emergency response. Based on the severity of floods and droughts from historical records, the project was implemented in ten

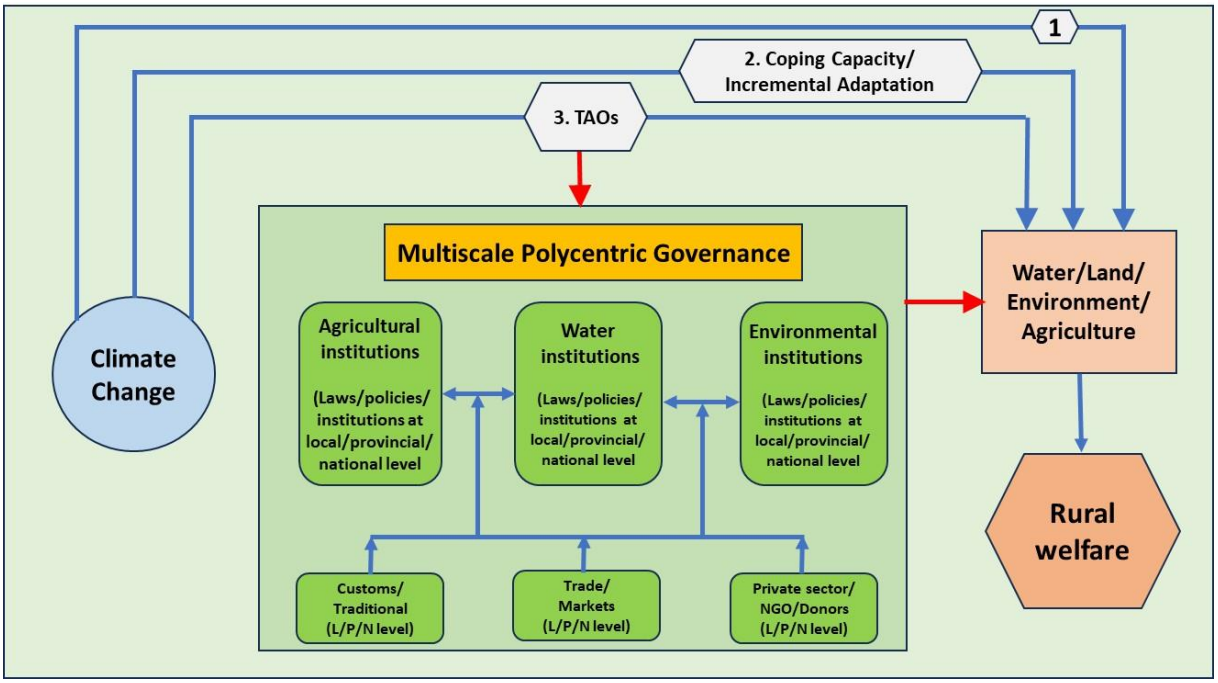
river basins, including Malwathu Oya. The River Basin the Kelani Ganga, Attanagalu Oya, Gal Oya, Gin Ganga, Nilwala Ganga, Mahaweli, Maha Oya, Kala Oya, and Deduru Oya.

The **CSIAP** intervention aimed to improve the productivity and climate resilience of the smallholder agriculture sector in selected vulnerable areas. The CSIAP had three major components: agriculture production and marketing, water for agriculture, and institutions. The first component focused on climate-smart agriculture and water technology and Marketing. The second component focused on rehabilitation, operation, and maintenance of irrigation systems and emergency response. The third component aimed to ensure the sustainability of improved climate resilience by strengthening the capacity of existing institutions (World Bank, 2019).

2. Methodology

To assess polycentric governance, transformation adaptation, the performance of institutions, and their impacts and outcomes on social welfare requires a broader framework. Climate change can negatively impact water, land, and environment sectors, and the converging impacts affect the agriculture sector and, ultimately, rural welfare (arrow 1 in Figure 2). Adaptation interventions (coping mechanisms or incremental adaptation) can enhance resilience and reduce the negative welfare impacts due to climate change (arrow 2 in Figure 2). Transformative adaptation options (TAOs) can further reduce the impact and have a systemic change to enhance rural welfare sustainably. However, to realize the potential benefits, TAOs must channel through a proper governance structure (arrow 3). Evidence shows that multi-scale polycentric governance enables the interventions to yield full benefits (Astrom 2010).

Figure 2: Framework for analyzing polycentric governance and performance of institutions.



Source: Authors based on Saleth et al. 2023

In assessing the impact pathways from climate change to adaptation options to rural welfare, the governance role of institutions should be adequately understood. The study first identifies the institutions in agricultural, water, and environmental systems, customary or traditional institutions, markets, and trade, and the private sector associated with planning, implementation, monitoring, and evaluation. Next, we assess the polycentric and transformative nature of the adaptation interventions. A detailed analysis of the linkages between the performance of institutions and the impacts of interventions requires an elaborate econometric analysis. The econometric analysis will be conducted through a multi-stakeholder survey (Saleth et al., 2023). This paper will only focus on the institutional mapping analysis of different interventions and a preliminary analysis of the polycentric and transformative nature of interventions.

2.1 Institutional Mapping of Interventions

The institutional mapping of interventions is relevant for two stages generally encountered in a water resources development project focusing on agriculture: project planning (formulation) and project implementation. The project implementation phase was further divided into implementation (of activities) and monitoring and evaluation (M&E). In the Sri Lankan context, the planning phase of national-level projects is generally carried out about national policies, development plans, and strategies. At this phase, the National Planning Department under the Ministry of Finance and the water and agriculture sector institutions play a major role.

Organizations that closely deal with Farmer Organizations (FOs) and Community-Based Organizations (CBOs), such as the Department of Agrarian Development (DAD), Irrigation Department (ID), Department of National Community Water Supply (DNCWS), and the National Water Supply and Drainage Board (NWSDB) convey the community needs at this stage. This is because the number of beneficiaries can sometimes be about a million, and there is no effective mechanism to engage all of them at a project planning stage. However, field discussions with farmers disagree with the projects formulated for their communities.

However, specific interventions (such as the type of repairs to an irrigation system, roads, and other social infrastructure, particular time of implementation, etc.) are generally implemented with the engagement of the community. Therefore, it may be noted that strict boundaries between planning and implementation are impossible to establish. The following analysis and the observations are based on a survey of project documents and a limited consultation with selected project staff. They must be corroborated further through key informant interviews, focal group discussions, or a stakeholder survey.

It may also be noted that the selected interventions' scope and focus are different. Therefore, the participation of other institutions could range from mandatory to “not required.” For example, CRIP focuses on flood and drought management at basin scale, and therefore, the participation of institutions dealing with fisheries may not have been necessary.

Table 3 gives the institutional mapping of four interventions, which are multi-scale, multi-sector projects. The leading institutions involved in the planning are agriculture, water, and the environment. Some salient features from mapping, from the point of polycentric governance, are:

- Departments of Irrigation and the Department of Agrarian Development (DAD) are involved in all aspects of interventions: planning, implementation, monitoring, and evaluation.
- The provincial government ministries and district-level councils also played a role in implementation. However, they are not involved in planning interventions, and their role is unclear.
- Participation of the environment ministry, or the Climate Change secretariat as the nodal agency for adaptation and mitigation, is missing in some interventions.
- The private sector's participation was limited to the implementation of projects.
- Advanced educational institutes, like universities, are also missing in planning these adaptation interventions.
- The participation of Ministries of Livestock Development and Fisheries and Aquatic Resources and associated institutions, critical institutions for integrated responses, was limited to CSIAP and CRIWMP only.
- Agrarian Services Centers are critical partners at the regional level, but participation was limited to CSIAP and CRIWMP only.
- Provincial/ departments of irrigation participation was present in CRIWMP, CSIAP and CRIP,
- The Ministry of Environment, and especially the Forest Department and Department of Wildlife Conservation, were involved in CRIWMP, CSIAP and NWPCP,
- Ground-level participation was absent in planning, such as those of farmer groups, farmers, community groups, local NGOs These groups are the ultimate beneficiaries of the interventions.

Table 3:Institutional mapping of four adaptation interventions (P=Planning, I = Implementation, ME= Monitoring and Evaluation)

Sector	Institutions	CRIWMP			CRIP			CSIAP			NWPCP		
		P	I	ME	P	I	ME	P	I	ME	P	I	ME
Agriculture	Ministry of Agriculture (MOA)	Y	Y		Y	Y	Y	Y	Y	Y			
	Department of Agriculture	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Dept of Agrarian Development (DAD)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ministry of Livestock Development							Y	Y	N			
	Ministry of Fisheries & Aquatic Resources	N	Y	N				Y	Y	N			
	Provincial Dept. of Agriculture	N	Y	Y				N	Y	Y	N	Y	Y
	District Agriculture Committee	N	Y	y				N	Y	Y	N	Y	N
Water	Ministry of Mahaweli Development and Environment[1]	Y	N	N				Y	Y	Y			
	Mahaweli Authority of Sri Lanka				Y	Y	Y	N	Y	N	Y	Y	Y
								Y	Y	Y			
	Ministry of Irrigation	Y	Y	Y							Y	Y	Y
	Irrigation Department	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	National Water supply and drainage boards	Y	Y	Y	Y	Y	N						
	Provincial Irrigation Departments	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y
								N	Y	Y	N	N	Y
	Dept of National Community Water Supply	Y	Y	N									
Climate	Dept of Meteorology	Y	Y	N	Y	Y	N				Y	Y	N
Environment	Ministry of Environment /Climate Change Secretariat	Y	N	Y							Y	N	N
	Forest Department	N	Y	N				N	Y	N	Y	Y	N
	Department of Wildlife conservation	N	Y	N				N	Y	N	N	Y	N

[1] Ministry of Mahaweli Development is currently a part of Ministry of Irrigation, while the Ministry of Environment is separate.

Table 3. Continued

Sector	Institutions	CRIWMP			CRIP			CSIAP			NWPCP		
Sector	Sector	P	I	ME	P	I	ME	P	I	ME	P	I	ME
Environment	Central Environment Authority										Y	Y	Y
	National Hydrology Committee										N	Y	N
	Geological Survey & Mines Bureau										Y	Y	N
	Sri Lanka Land Reclamation and Drainage Corporation				Y	Y	N						
Disaster Management	Ministry of Disaster Management	Y	N	N	Y	N	N				Y	N	N
	Disaster Management Center	Y	Y	Y	Y	Y	Y				Y	Y	Y
	Irrigation Department	Y	Y	Y	Y	Y	Y						
	NBRO				Y	Y	Y						
	Ministry of Education				Y	N	N						
Administrative/ Rural development	Ministry of Finance, Economic Stabilization and National Policies	Y	N	Y	Y	N	Y	Y	N	Y	Y	N	Y
	Ministry of Rural Development												
	Road Development Authority				Y	Y	N						
	Provincial Councils	Y	Y	Y				N	Y	N			
	Ministry of National Policies[2]							N	Y	N			
	Ministry of Economic Affairs[3]							N	Y	N			
	District Secretary	N	Y	Y	N	Y	N	N	Y	N			
	Divisional Secretary	N	Y	Y	N	Y	N						
	Grama Niladhari (GN)	N	Y	N				N	Y	N			
	Dept of project management and monitoring	N	N	Y	N	N	Y	Y	N	Y	N	N	Y
Investment banks/	World Bank				Y	Y	Y	Y	Y	Y			
	ADB										Y	Y	Y
	GCF	Y	Y	Y									

[2] Currently linked to the Ministry of Finance

[3] Currently linked to the Ministry of Finance

Donors/International organizations	UNDP (as an accredited institution) IWMI	Y Y	Y Y	Y N			

Table 3. Continued

		CRIWMP			CRIP			CSIAP			NWPCP		
Sector	Institutions	P	I	ME	P	I	ME	P	I	ME	P	I	ME
NGOs/COs	Civil Society organizations	N	Y	Y							Y/N	Y	N
Private sector	Marketing groups	N	Y	N				N	Y	N			
	Mahaweli Consultancy Bureau (Pvt) Limited,										N	Y	N
	NEM Construction (Pvt) Ltd,										N	Y	N
	China State Construction Engineering Corporation Limited										N	Y	N
	Technical consultancy firms	N	Y	N	N	Y	N						
	Civil Works Contractors	N	Y	N									
Farmers groups	Farmer organizations/farmers	N	Y	Y	N	Y	Y	N	Y	N	N	Y	N
	Women's group	N	Y	Y	N	Y	N	N	Y	N			
Markets	Farmer markets	N	Y	N				N	Y	N			
Universities/ Educational institutions	Universities (Peradeniya, Moratuwa, Rajarata, Sabaragamuwa, Ruhuna)	N	Y	N	N	Y	N						
Customary/ Traditional		N	Y	N				N	Y	N			
Social safety nets	Compensation/rehabilitation/resettlement	N	Y	N	N	Y	N	N	Y	N	N	Y	N

Source: Authors' compilation from project documents and personal communication with project officials (see annexes A1-A4)

2.2 Multiscale Polycentric Governance

In the case of **CRIWMP**, the proposed formation of a Cascade Management Committee (CMC) is an innovative governance and management arrangement where all the water users (FOs, CBOs, fisheries, women organizations) and relevant government organizations (Divisional Secretary, DAD, PID, drinking water, forests, and wildlife officials, etc.) expect to participate. CMCs desire to empower women to manage natural resources, minimize disputes, and facilitate the commercialization of agriculture. This intervention awaits policy and legal support to be fully functional. However, the DAD's formation of Cascade Farmer Organizations, which is expected to be initiated within 2023, will enable bringing agriculture and irrigation sector organizations and multiple water users to a common forum and making decisions regarding water and land use.

The **CRIP** managed to reach a consensus in data sharing and information dissemination between four major institutions involved in disaster management. These institutions are the Disaster Management Centre, Irrigation Department, National Building Research Organization, and Department of Meteorology. However, the available documents and interviews do not clarify whether this will result in a long-term agreement or whether the understanding among the institutions lasts beyond the project period.

The **CSIAP** established Farmer Producer Societies, which could contribute to polycentric governance through the proposed Cascade Farmer Organizations planned by the DAD. This aspect needs to be studied further.

The available literature and consultations did not reveal elements of polycentric governance attempted by the **NWPCP**. However, this may be due to the delay in starting village irrigation systems rehabilitation and needs to be studied further.

2.3 Transformative adaptation

The **CRIWMP** identified at the planning stage that rehabilitation alone will not enhance climate resilience and adopted an ecosystem-based integrated approach to develop the cascades. Accordingly, the upstream catchment, the Tank, and the downstream irrigation and drainage system were restored or upgraded as a single unit. The project invested in updating the technical guidelines for irrigation design incorporating the current trends of climate variation. A detailed operation, maintenance, and disaster response (Standard operating procedures for floods and droughts at Tank level) and seasonal cultivation planning using seasonal weather forecasts, measurement of rainfall, and storage capacity for improved and scientific water management are expected to transform the conventional rehabilitation to a more sustainable status. The incorporation of climate-smart agriculture practices and drinking water into the cascade management system builds on traditional management practices and incorporates modern technologies as well. The cascade water resources development and management plan contain irrigation, agriculture, livestock and fisheries, drinking water, groundwater, and ecosystem conservation. Therefore, this conceptual framework attempts to introduce Integrated Water Management (IWRM) principles with a bottom-up approach. However, these innovations are being implemented in about 10% of selected river basin's minor tank irrigation systems. Unless national policies and legislation recognize them, there may not be system-wide changes or long-term impacts.

CRIP has elements of transformative adaptation, as well. The project used the river basin as a planning unit for flood and drought management interventions, and the interventions were designed based on the investigations carried out by computer models. The project's outputs contributed to another major development project by the World Bank, and further studies are required to assess its total contribution to transformative adaptation. However, CRIP is unlikely to impact at multiple scales, as its activities focus only on river basin level flood management. Policy and legal support may be required for system-wide and long-term impacts.

The **CSIAP's** major transformative adaptation activities included Farmer Producer Societies, promoting climate-smart agriculture, and enhancing climate resilience through better profitability in agriculture. Rehabilitation of irrigation systems was also carried out through an inclusive package of interventions that address the needs of the command area, catchment area, and landscape management. In addition, river basin level hydrological assessments were used to assess water availability and vulnerable areas and plan the interventions. This can be considered a pioneering attempt to design minor tank irrigation improvements through river basin planning. However, policy and legal support may also be required for system-wide and long-term impacts in this case.

The **NWPCP** is a component of the more extensive Mahaweli Water Security Investment Programme (MWSIP) funded by the ADB. This project's major transformative adaptation concept is to improve the cropping intensity (and thereby the productivity) through trans-basin water diversions. This can be considered a deviation from previous conventional trans-basin diversions, which focused on expanding the irrigated areas. However, the rehabilitation of the village irrigation systems under the project is yet to begin. Therefore, a complete description of transformative adaptation options cannot be made at this stage. The project's ability to provide new knowledge, policy direction, or impact multiple sectors is not visible. Policy and legal reforms may still be required to sustain the positive results in this case.

All four interventions could make their interventions more sustainable in the long term if the projected climate were considered at the design stage. The available literature does not reveal such an assessment. The characteristics of transformative adaptation in the four interventions can be summarized as follows (Table 4).

Table 4. The characteristics of transformative adaptation in the four interventions

Intervention	Characteristics of Transformative Adaptation					
	Restructuring	Path-shifting	Innovative	Multi-scale	System-wide	Persistent
CRIWMP	Yes	Yes	Yes	Yes	No	No
CRIP	Yes	Yes	Yes	No	No	No
CSAIP	Yes	Yes	Yes	Yes	No	No
NWPCP	Yes	Yes	No	No	No	No

Transformative adaptation options encompass various strategies to create more resilient, sustainable, and equitable societies in the face of environmental challenges. A detailed analysis of three transformative adaptation options was considered from the above adaptation programs.

- **TAO 1** - Forming cascade management committees and strengthening FOs,

- **TAO 2** - Diversification to high-value crops and climate-smart agricultural practices in CRIWMP and CSIAP projects,
- **TAO 3** - Basin Investment planning accounting climate change risks in the CRIP project

Table 4 shows professional's perceptions and knowledge about transformative adaptation characteristics embedded in the above three interventions.

Table 4. Stakeholder's perceptions on transformative characteristics in adaptation interventions

Characteristics	**Forming Cascade Management Committees and Strengthening Farm Organization.**	**Diversification of high-value crops and climate-smart agriculture practices**	**Basin investment planning accounting climate change risks**
Relevance	Forming cascade management committees take a holistic approach to water resource management, considering the entire water cascade from source to downstream users.	Climate-smart agriculture practices involve precision farming and the use of drought-resistant (Millet, Maize) or heat-tolerant crop (Ground nuts, Onion) varieties to contribute to sustainable and economically viable agriculture by optimizing resource use in response to climate challenges.	Basin investment plans consider climate change risks to be relevant in building resilience to extreme weather events such as floods, droughts, and thunderstorms.
Coherence	Cascade management committees and farm organizations have a diverse mix of ages (youngers, older) and education levels of farmers (graduates, primary education), and knowledge is exchanged coherently between scales to enhance overall agricultural resilience.	This TAO considers cultivating multiple varieties of crops to reduce risks of crop failure due to unfavorable weather conditions or pests. This, in turn, can contribute to economic sustainability.	In the CRIP project, basin investment plans to account for climate change risk involve aligning strategies, actions, and investments to address the potential impacts of climate change in a specific geographic area such as Anuradhapura, Kurunagala, etc.
Restructuring	TAO enhances water efficiency, reduces wastage, and contributes to sustainable water resource management.	This TAO changes a small area to grow a high-value production system.	TAO moves from the Basin Investment plans to restructuring measures to enhance flood control infrastructure, such as the construction of levees, embankments, or other protective structures to minimize the impact of floods.
Path shifting	Cascade Management Committees identify strengths, weaknesses, opportunities, and threats through discussions and communications with all	By carefully planning and executing the path-shifting process focusing on diversification into high-value crops and climate-smart agriculture practices,	Basin investment plans consider upgrading infrastructure (such as dams, reservoirs, and water supply systems) to

	levels of the organization to make effective cascade management frameworks. For example, there has been a shift from improper water distribution to proper water management under water master "Well Widane" guidance.	farmers can position themselves for increased profitability, resilience, and sustainability in the face of changing agricultural landscapes. Adaptation option shifts towards high-value commodities from low-value commodities (Paddy move to Green Gram) Shift from monoculture farming to stall feeding farming system with crop and livestock integration.	mitigate or adapt to future climate change.
Innovative	Established legislation and policies for cascade management organizations and considered cascade-level water management with maintenance of inter-tank facilities.	TAO is innovative in moving from surface irrigation to drip irrigation, sprinkler irrigation, or lateral irrigation by moving the irrigation system.	Basin investment plan to account for climate risk can involve adjusting the current approach to incorporate climate resilience, adopting new technologies, or implementing nature-based solutions.
Multi-scale	Improved the capacity of FOs in the tank cascade to sub-watershed level.	TAOs influence the cropping system in and outside the canal command area (Eg. Crop rotations in rainfed and irrigated areas).	TAO not only considered beneficiaries in the basin area but also included local communities, businesses, governmental organizations, and environmental groups.
System-wide	TAO contributes to sustainable water uses and soil conservation, mitigating the negative impacts of agricultural activities on natural resources.	TAO is an ideal solution to water scarce irrigation systems in a river basin.	Sustainable basin management contributes to the social and economic well-being of communities. This includes job creation, income generation, and improved living standards.
Persistent	TAO conserves water through cascade management, such as securing water in drought conditions, but also for agroecology and sustainable farming,	Diversification of high-value crops provides farmers with multiple income streams, reducing their vulnerability to market fluctuations and external shocks.	Investment in climate-resilient infrastructure, such as water storage and distribution systems, ensures that the basin can adapt to changing climate

	contributing to environmental conservation.		conditions over the long term, mitigating the impact of extreme events.

3. Conclusions

The analysis shows that all four adaptation options exhibit elements of transformative adaptation options and polycentric governance at varying levels. CSIAP and CRIWMP focus on village (minor) irrigation and cascade systems. There are many similarities between the two projects in terms of the participatory nature in planning specific interventions, deviation from conventional irrigation rehabilitation, and the focus on climate resilience. Some activities do not overlap. For example, the CSIAP adopted a river basin-level hydrological assessment to identify the target areas. In contrast, the CRIWMP adopted an approach to identify vulnerability based on poverty, CKDu incidence, and flood damages. The CSIAP focuses more on agriculture, while the CRIWMP adopts an integrated approach to managing water and associated resources. The adaptation options are considerably similar in terms of participatory nature in designing specific interventions. The CRIP is slightly different in its approach and objectives from the other 3. It focuses on river basin-level interventions leading to flood and drought management. This is a substantial deviation from conventional disaster management projects. The project also directly targets climate resilience. The available information is insufficient to ascertain whether the attempts at polycentric governance will be sustained in the long term.

The NWPCP conceptually deviates from previous trans-basin water diversion projects by planning to improve the cropping intensity of existing irrigation systems rather than expand irrigated areas. However, the irrigation system rehabilitation part has not begun yet. Therefore, there is not enough information to assess the polycentric governance aspects of the project. Furthermore, it is unclear whether the effects of projected climate change were considered when the diversions were designed. Therefore, the sustainability of the benefits needs further assessment.

Several barriers to implementing transformative adaptation are cited in the literature. They include the need for high investments in terms of human, financial, and time resources, relatively longer time taken for benefits to reach the communities, the challenges to the 'status-quo' of the existing system, and limited mandates of the institutions planning these interventions (Fedele et al., 2019).

These barriers were evident in the implementation of CRIWMP. The progress of transformative types of interventions, such as the formation of Cascade Management Committees and their legal recognition, lags behind that of physical infrastructure. It is also unclear whether the innovations of the CSIAP and CRIWMP will be sustained after the project periods without adequate policy and legal support. Although both projects provide many lessons for policy formulation in water and agriculture, it is doubtful whether policymakers will give the required priority to such aspects during a period of political and economic crisis.

Transformative and polycentric elements observed in the interventions will require policy and legal support to be sustainable in the long term. This might require a change of the current top-down approach in water-related policymaking. The elements of transformative adaptation and polycentric governance identified in the interventions could be a basis for introducing IWRM with a bottom-up approach. This would require bringing in those different elements into a common framework of water resources development and filling the gaps.

The sustainability could be further enhanced by designing the interventions, especially expensive inter-basin diversions, not only based on climate change projections but also from community participation. Therefore, a detailed field- level assessment can be recommended to gain further insights and keep them

recorded to have them available in planning stages for a more enabling and stable socio-political environment.

4. References

Amarasinghe, U.A.; Amarnath, G.; and Alahacoon, N., 2020. Vulnerable hotspots to water and agricultural risks in Sri Lanka. *Neela Haritha Clim. Chang. Mag. Sri Lanka*, *3*, pp.1-11.

Dharmasena, P.B. 2020 Cascaded tank-village system: present status and prospects. *Agricultural Research for Sustainable Food Systems in Sri Lanka: Volume 1: A Historical Perspective*, pp.63-75. DOI:10.1007/978-981-15-2152-2_3

Disaster Management Center (DMC) 2017. Annual report 2017. Colombo, Sri Lanka: Disaster Management Center., Available at: https://www.dmc.gov.lk/images/pdfs/AnnualReports/2017_compressed.pdf

Fedele, G.; Donatti, C.I.; Harvey, C.A.; Hannah, L.; Hole, D.G. 2019. Transformative adaptation to climate change for sustainable social-ecological systems. *Environmental Science & Policy*, *101*, pp.116-125.

Green Climate Fund (GCF) 2016. Strengthening the resilience of smallholder farmers in the Dry Zone to climate variability and extreme events through an integrated approach to water management. Available at https://www.greenclimate.fund/sites/default/files/document/funding-proposal-fp016-undp-sri-lanka.pdf

Infortechideas., 2022. Upgrading guideline for irrigation works. Available at : https://infotechs-ideas.com/archives/works/updating-guidelines-for-irrigation-work

Mahaweli Consultancy Bureau 2014. Environmental Impact Assessment December 2014. SRI: Water Resources Development Investment Program Northwestern Province (NWP). Available at: https://ewsdata.rightsindevelopment.org/files/documents/01/ADB-47381-001_wEqGaQJ.pdf

Ministry of Environment.,2022. Report of Third National Communication of Climate change in Sri Lanka. Available at: https://unfccc.int/sites/default/files/resource/Third%20National%20Communication%20of%20Sri%20Lanka.pdf

Ministry of Irrigation and Water Resources Management Irrigation Department., 2014. Environmental Assessment and Management Framework. Available at: https://documents1.worldbank.org/curated/en/761811468308350082/pdf/E44190REV0SAR000Box38239B00PUBLIC0.pdf

Ministry of Mahaweli Development and Environment (MMDE)., 2018. Semi-Annual Environmental Monitoring Report No. 3 FOR NWPCP. Available at: https://www.adb.org/sites/default/files/project-documents/47381/47381-002-emr-en_9.pdf

Ministry of Mahaweli Development and Environment MMDE.,2017. Environmental Impact Assessment SRI: Mahaweli Water Security Investment Program Northwestern Province Canal Project. Available at: https://www.adb.org/sites/default/files/project-documents/47381/47381-002-eia-en.pdf

Morrison, T.H.; Adger, W.N.; Brown, K.; Lemos, M.C.; Huitema, D.; Phelps, J.; Evans, L.; Cohen, P.; Song, A.M.; Turner, R.; Quinn, T. 2019. The black box of power in polycentric environmental governance. *Global Environmental Change*, *57*, p.101934.

Nanayakkara, V.K., 2017. Sri Lankan Structures of Governance. *Mount Lavinia, Sri Lanka,* pp .379-389

Oberlack, C.; Boillat, S., Brönnimann, S.; Gerber, J.D.; Heinimann, A.; Speranza, C.I.; Messerli, P.; Rist, S.; Wiesmann, U. 2018. Polycentric governance in telecoupled resource systems. *Ecology and Society*, *23*(1). https://doi.org/10.5751/ES-09902-230116

Ostrom, E. 2010. Beyond markets and states: polycentric governance of complex economic systems. American economic review, 100(3), pp.641-672.

Panabokke, C.R.; Sakthivadivel, R; Weerasinghe, A.D. 2002. *Evolution, present status and issues concerning small tank systems in Sri Lanka* (No. H036586). Colombo: International Water Management Institute.

Panwar, V.; Sen, S. 2020. Disaster damage records of EM-DAT and DesInventar: a systematic comparison. *Economics of disasters and climate change*, *4*(2), pp.295-317.

Rodrigo, C.; Samarakoon, L.; Rajapakse, S.; Lanerolle, R.; Sheriff, R. 2013. Kidney disease in the elderly: a Sri Lankan perspective. *Saudi Journal of Kidney Diseases and Transplantation*, *24*(6), pp.1285-1290.

Saleth, R.M.; Amarasinghe, U.A.; Amarnath, G.; El Mekki, A.A.; Brouziyne, Y.; Chandrasekara, S.; Ukwattage, U. 2023. *Climate change, transformative adaptation options, multiscale polycentric governance: Methodological framework for impact evaluation of rural welfare*. CGIAR Initiative on Climate Resilience

World Bank 2014. Climate Resilience Improvement Project- Sri Lanka. Project Appraisal Document. Available at: https://documents1.worldbank.org/curated/en/444991468303013994/.

World Bank. 2019. Climate Smart Irrigated Agriculture Project, Sri Lanka. Project Appraisal document. Available at : https://csiap.lk/project_appraisal_document.

Annexures

Annex A1. Institutional Mapping of the Climate Resilient Integrated Water Management Project (CRIWMP)

Why this adaptation option?

The Climate Resilient Integrated Water Management Project (CRIWMP) aimed to enhance the climate resilience of vulnerable communities in the Dry Zone of Sri Lanka. Climate change, characterized by increasing temperatures and unpredictability of rainfall, affects the agriculturally dependent livelihoods in the dry zone. The most affected communities are those with livelihoods dependent on village irrigation systems (VIS). The VISs depend mostly on local rainfall, and a small tank catchment area. The VIS communities have small land holdings. After the ending of a 30-year-old ethnic conflict, village communities wanted to recover their livelihood by reviving the long-neglected social and economic infrastructure. However, the recovery would be a slow process unless the specific vulnerabilities of the communities are addressed. CRIWMP focused on reducing these specific vulnerabilities.

There are barriers to the climate resilience of smallholder farmers. Those barriers found at the CRIWMP project formulation were.

- Livelihood disruptions due to climate change-induced deterioration of irrigation infrastructure,
- Inadequate application of climate-smart agricultural practices,
- Inadequate access to safe and reliable drinking water supply affecting the communities' health and productivity, and
- Reduction of community's adaptation capacity due to inadequate early warning of weather and climate variability.

Although a direct relationship was not established, poor quality drinking water contributed to the chronic kidney disease of unknown etiology (CKDu), which was predominant in the Dry Zone. Considering the diversity of issues to be addressed, it was agreed that an integrated approach is necessary for the improvement of water and associated resources management to enhance the climate resilience of the Dry Zone community.

Brief description of CRIWMP

The objective of CRIWMP is to "strengthen the resilience of smallholder farmers, particularly women, in the Dry Zone through improved water management to enhance lives and livelihoods". The GCF funds the project. The fund Level expectations, as well as the outcomes, of the project, are "increased resilience of health and well-being, and food and water security and increased resilience and enhanced livelihoods of the vulnerable smallholder farmers in the Dry Zone of Sri Lanka.

The three inter-linked Outputs, which are also described as Components, are:

(i) Upgrading village irrigation systems and scaling up climate-smart agricultural practices;

(ii) Enhancing decentralized water supply and management solutions to provide safe drinking water to vulnerable communities; and

(iii) Strengthening early warning, forecasting, and water management systems to enhance the adaptive capacity of smallholder farmers to droughts and floods

The Project was planned by a Technical Working Group appointed by the (then) Ministry of Mahaweli Development and Environment (MMDE)[4]. Based on the vulnerability assessments, the Yan Oya, Malwathu Oya, and Mi Oya were the focused river basins for the CRIWMP. Within the river basins, the tank-cascades were the planning and implementation unit for the integrated approach. Tank cascades were selected from the three river basins to carry out village irrigation system upgrading activities. Climate-smart agricultural practices were enhanced within the river basins, with a priority order the selected cascades. Climate and weather early warning improvements focused on the three river basins. Drinking water solutions were applied to seven administrative districts associated with the selected river basins (Anuradhapura, Polonnaruwa, Mannar, Vavuniya, Trincomalee, Kurunegala and Puttalam), while the priority order of interventions was the cascade, river basin, and the district area outside the river basin.

Involvement of the beneficiaries in planning specific interventions during the implementation period was attained through participatory rural appraisal methods. Civil Society Organizations (CSOs) mobilized the communities for this purpose. The Project introduced a methodology called "Participatory Climate Risk Vulnerability Capacity Assessment" (PCR-VCA) to assess specific vulnerabilities in selected cascades, in a participatory manner. Beneficiary participation was also ensured through the "Preliminary Investigation Report" (PIR) process to identify irrigation system upgrading priorities and participatory monitoring committees were formed during the construction activities to support GRM process.

Main activities/sub-activities

The main activities, identified on the basis that they could be implemented independently, were:

i. Upgrading of village irrigation systems (VIS) in selected cascades in a climate-resilient manner

This activity expects to facilitate improved and climate-risk-informed water management for agricultural production by upgrading village irrigation systems in the selected cascades. Upgrading of the VIS, which included the restoration of cascade-related ecosystems such as upstream reservations and downstream interceptors, used a participatory approach, including Farmer Organizations (FOs), field officers of agriculture-related government institutions, private sector and local NGOs, private sector consultancy firms, and contractors. Operation and maintenance (O&M) and financing plans were introduced after the physical upgrading.

ii. Scaling up climate-smart agricultural practices

The adoption of diversified, and climate-resilient livelihood practices related to climate-smart agriculture by the project beneficiaries. The technology transfer, improved extension services, business development training, and market linkages, with support from the private sector for technology and financing was part of the implementation. It strengthens the women producers, while improving technical capacity and knowledge management by the Agrarian Service Centers (ASC), local field officials and community organizations for climate-risk-informed water

[4] At present, Mahaweli development is under the purview of the Ministry of Irrigation and the Ministry of Environment operates separately.

management and climate-smart agriculture. It also involved developing and disseminating climate-resilient agricultural practices with targeted enterprise development for women.

ii. Decentralized water management solutions

This activity aimed at providing safe, year-round drinking water to vulnerable communities, through a multi-pronged partnership approach. It helps to replenish sources, build storage, supply clean and safe drinking water and address root causes of water quality issues. Project's resources were used to improve the capacity of local officials, CBOs and FOs to incorporate climate risks in the design and management of sustainable rural drinking water solutions (community water supply systems (CWSS), advanced filters, and rainwater harvesting tanks). Sub-activities included improving the capacity of water-supply support staff at district/divisions and selected partner organisations (NGOs) and CBOs, to implement and maintain community-based climate change risk-informed drinking water-related interventions.

iv. Strengthening early warning, forecasting, and water management systems

This activity helped strengthen climate and hydrological observational and forecasting systems to enhance water management and adaptive capacity of smallholder farmers to droughts and floods. Interventions leading to this output include providing access to weather/climate-related knowledge services, such as advice on future seasonal conditions (for agricultural planning) and early warning of storms and flooding for flood and water management including the planning of water release from irrigation tanks. The major sub-activities of this component are:

- Establishing effective monitoring systems for drought, floods, and water management
- Co-developing and disseminating weather and climate-based advisories for agricultural and water management through ASCs and FOs to farmers and village water managers
- Developing climate-risk management response measures based on advisories and forecasts for agriculture, water management, and flooding in cascade systems

v. Integrated management of water and associated resources within a cascade

The Project developed a Cascade Water Resources Development and Management Plan (CWRD&MP) to enable integrated management of water and associated resources within a cascade, and thereby enhance climate resilience. The Plan comprises several sub-components as follows:

- VIS upgrading
- Operation, maintenance, and disaster response in VISs
- Climate smart agriculture
- Environmental management and catchment conservation
- Drinking water
- Groundwater

An institutional arrangement for implementing the plan, which comprises of a Cascade Management Committee (CMC) comprising all the water-related stakeholders within the cascade, is also proposed under the CWRD&MP.

Institutional mapping: Institutions involved in planning, implementation, M & E, CRIWMP

Sector	Institution	Planning	Implementation[5]	M & E
Agriculture	Department of Agriculture	Yes	Yes	
	Provincial Departments of Agriculture (PDOA)	No	Yes	Yes
	Provincial Departments of Animal Production & Health	No	Yes	No
	National Aquaculture Development Authority (NAQDA)	No	Yes	No
	Department of Agrarian development (DAD)	Yes	Yes	Yes
Water/Environment (Includes irrigation)	Department of Agrarian Development	Yes	Yes	Yes
	Ministry of irrigation	Yes	Yes	Yes
	Ministry of Environment (Climate Change Secretariat as NDA)	Yes	No	Yes
	Provincial Irrigation Departments (NWP, NCP, EP, NP)	No	Yes	Yes
	National Water Supply and Drainage Board (NWSDB)	Yes	Yes	Yes
	Department of National Community Water Supply (DNCWS)	Yes	Yes	
	Irrigation Department (ID)	Yes	Yes	No
Disaster Management	Ministry of Disaster Management (Does not operate now)	Yes	No	No
	Disaster Management Center	Yes	Yes	Yes
	Irrigation Department	Yes	Yes	Yes
Climate services	Department of Meteorology	Yes	Yes	
Donors	Green Climate Fund (GCF), UNDP (as an accredited institution)	Yes	No/yes	Yes
IGOs/INGOs	UNDP, IWM[6]I	Yes	Yes	Yes
NGOs/COs	(CSOs) RC, Janathakshan, Palm Foundation, SAPSRI			
Financial institutions/ banks	Ministry of Finance, Green Climate Fund	Yes	Yes	Yes
Private sector	Technical consultancy firms, Firms providing agricultural inputs, Contractors	No	Yes	No
Universities/educational institutions	Peradeniya, Moratuwa, Rajarata, Sabaragamuwa	No	Yes	No
Insurance companies/Institutions				

5 Includes annual planning

[6] IWMI was not involved in M&E

Service providers	Civil Society Organizations (CSO), Consultancy firms, Firms providing agricultural inputs	No	Yes	Yes
WUA/FO leaders	Farmer Organizations, CBOs, Women FOs,	No	Yes	Yes
Marketing institutions	Farmer markets, Private sector (SR Bio Foods)	No	Yes	No
Customary/ traditional				
Price control				
Trade regimes				
Social and Environmental safety nets	MOI, District Secretariat, Divisional Secretary, GN,	Yes/No [7]	Yes	Yes

Roles and responsibilities

Institution	Roles and responsibilities
GCF	Funds disbursement, M&E
MOF	Funds disbursement to MOI, M&E at the national level
MOI and PMU	Project implementation, Fund disbursement, Coordination with government entities, M&E, Implementing Grievance Redress Mechanism (GRM)
ME and CCS	Climate Change Secretariat (CCS) under the Ministry of Environment (ME) is the National Designated Authority (NDA) for GCF
UNDP	Accredited Entity of GCF, providing technical support, M&E, GRM
DAD	Dissemination of advisories for better water management, holding seasonal cultivation meetings, supporting seasonal planning, dissemination of CSA packages through ASCs, supervision of O&M, VIS upgrading
PDOA	Dissemination of climate-smart agricultural packages, extension services
DoA	CSA guidelines
PID	VIS upgrading
District Secretariat	District-level coordination, Supporting GRM
Divisional Secretariat	Divisional-level coordination, Supporting GRM
CSO	mobilization of the community for the project activities, participatory demarcation of reservations and implementing ecosystem restoration, Mobilizing for the GRM (service providers)
Private sector	Provision of agricultural inputs, civil works contractors, multi-disciplinary consultancy services

7 MOI was involved in the initial planning and annual planning. Others were only during annual planning

NWSDB	support design and development of community water supply schemes and water purification and filtration systems, water quality testing and monitoring, and O&M of these investments
DNCWS	Support O&M of community water supply systems
ID	Technical support for flood modelling, Installation of stream gauges
DMC	Coordination of flood and drought management activities at District level
DOM	Climate and weather information, Identify training needs and conduct training
Universities/ academia	Provision of technological services (computer modelling, IT products)
IWMI	Participation in project planning Technical Group. Developing a cascade selection strategy during implementation

Annex A2. Institutional Mapping of the Climate Resilience Improvement Project (CRIP)

Why this adaptation option?

The Climate Resilience Improvement Project (CRIP) is implemented with the twin objective of reducing the vulnerability of exposed communities and properties to climate risks and improving the Sri Lankan Government's capacity to respond effectively to climate-related disasters, especially floods, and droughts. This intervention was initiated in response to the demand to address the early warning needs and flood management in some key river basins. It provides a "critical first investment drive" to manage disaster risks and provides a long-term investment plan to build disaster resilience (MIWRM&DM, 2018)

Brief description of CRIP

The main components of the project (according to the funds allocation) are (World Bank, 2019):

i. Development of basin investment plans (BIPs)
ii. Increasing climate resilience of infrastructure
iii. Project implementation
iv. Contingent emergency response

CRIP selected ten river basins: Kelani, Attanagalu Oya, Gal Oya, Gin Ganga, Nilwala Ganga, Mahaweli, Malwatu Oya, Maha Oya, Kala Oya, and Deduru Oya. The selection of these river basins was based on the severity of historical flood and/or drought events, and the affected people, infrastructure, and private and public assets, especially during 2010-2014 period. The project was implemented by local and foreign consultants.

Main activities/sub-activities

1. BIPs
    a. Flood and drought risk mitigation investment plans (BIPs) for ten priority basins
    b. Training and capacity building of the Government's counterpart team of engineers for developing BIPs
    c. Complete prioritized feasibility studies identified in Phase I BIPs
2. Resilience of Infrastructure
    a. Rehabilitation of flood damaged irrigation, drainage and flood control infrastructure;
    b. Upgrading of roads and related infrastructure including inadequate bridges for transport connectivity
3. Stabilizing unstable slopes in vulnerable schools for School Safety (World Bank, 2019)

Institutional mapping: Institutions involved in planning, implementation, M & E

Sector	Institution	Planning	Implementation [8]	M & E
Agriculture	Department of Agriculture (DOA)	No	Yes	No
	Ministry of Agriculture (MOA)	No	No	Yes
	Dept of Agrarian development (DAD)	no	Yes	
Water (Includes irrigation)	Ministry of Irrigation (MOI)	Yes	Yes	Yes
	Irrigation Department (ID)	Yes	Yes	Yes
	Provincial Irrigation Departments	No	Yes	no
	National Water Supply and Drainage Board (NWSDB)	Yes	Yes	No
	Sri Lanka Land Reclamation and Drainage Corporation (SLRDC)	Yes	yes	No
	Dept of Agrarian Development (DAD)	no	Yes	No
	Mahaweli Authority of Sri Lanka (MASL)	Yes	Yes	Yes
Disaster Management	Ministry of Disaster Management (Does not operate now)	Yes	No	No
	Disaster Management Center	Yes	Yes	Yes
	Irrigation Department	Yes	Yes	Yes
	National Building Research Organization (NBRO)	Yes	Yes	Yes
	Road Development Authority (RDA)	No	Yes	Yes
	Ministry of Education(M.Ed)	Yes	No	No
Climate services	Department of Meteorology (DOM)	Yes	Yes	Yes
	Land Use Policy Planning LUPPD	No	Yes	No
	Survey Department	No	Yes	No
	District Secretary (post disaster)	No	Yes	Yes
	Divisional Secretary	No	Yes	Yes
Donors/	The World Bank	Yes	yes	Yes
IGOs/INGOs				
NGOs/COs				
Financial institutions/ banks	Ministry of Finance (NPD, ERD),	Yes	Yes	Yes
Private sector	Technical consultancy firms, Contractors	No	Yes	No
Universities/ educational institutions	Peradeniya, Moratuwa, Rajarata, Sabaragamuwa, Ruhuna	No	Yes	No
Insurance companies				

8 Includes annual planning

Service providers	Consultancy firms	No	Yes	No
WUA/FO leaders	Farmer Organizations	No	Yes	Yes
Marketing institutions				
Customary/ traditional				
Price control				
Trade regimes				
Social and environmental safety nets	MOI, District Secretariat, Divisional Secretary, GN, CEA	Yes	Yes	Yes

Roles and responsibilities

Institution	Roles and responsibilities
World Bank	Funds disbursement, M&E, Annual planning, review of outputs
MOF	Funds disbursement to MOI, M&E at national level
MOI and PMU	Project implementation, Fund disbursement, Coordination with government entities, M&E, Implementing Grievance Redress Mechanism (GRM)
MOA	Involvement in M&E through the Steering Committee
ME	Ensuring environmental safety nets in place (EIA, IEE etc.) through CEA
DAD	Supporting minor irrigation flood drought impact analysis
DOA	Provision of drought data through NRMC and in related planning activities
RDA	Implementing solutions for roads and bridges
District Secretariat	District-level coordination, Supporting GRM, planning post disaster
Divisional Secretariat	Divisional-level coordination, Supporting GRM, planning post disaster activities
Private sector	Civil works contractors, multi-disciplinary consultancy services
NWSDB	Planning drinking water solutions during floods and droughts
ID	Rehabilitation of irrigation and drainage infrastructure, technical support for flood modelling, Installation of stream gauges
DMC	Coordination of flood and drought management activities at District level
DOM	Climate and weather information, Identify training needs and conduct training
MASL	Rehabilitation, Participation in the Steering Committee
NBRO	Landslide mitigation solutions for road, schools

Universities/ academia	Provision of technological services (computer modelling, IT products)
LUPPD	Provision of land use data to support climate-related analyses
Survey Dept.	Lidar data, digital topography
FO	Implementing mitigation options contracts, monitoring water shortages
SLRDC	Rehabilitation related to land drainage related infrastructure

Annex A3. Institutional Mapping of the Climate Smart Irrigated Agriculture Project (CSIAP)

What is CSIAP?

Climate Smart Irrigated Agriculture Project (CSIAP), hence being developed to uplift the agriculture livelihood of the small-scale tank-based farming community living in the most climatically vulnerable farming areas of the country. The Project Development Objective is to improve the productivity and climate resilience of small holder agriculture sector in selected hotspot areas. To achieve the above development objective, the project will be implemented under four components. The project will be implemented over a period of five years (2018 – 2024).

Project area and the focus groups

The project identified 11 districts; Kilinochchi, Mullaitivu, Anuradhapura, Polonnaruwa, Puttalam, Kurunegala, Trincomalee, Batticaloa, Ampara, Hambantota, and Moneragala (Figure 1); for project implementation. Further, the project covers 18 sub-watersheds of 10 river basins of Modragam Aru, Yan Oya, Mee Oya, Kala Oya, Peru Aru, Mandakal Aru, Hada Oya, Karanda Oya, Kirindi Oya and Manik Ganga. It is essential to understand that, this project primarily beneficiaries are the small holder farmers (over 470,000 smallholder farmers) in the climate change hot spot areas in the mentioned districts and watersheds (in hotspot areas of nearly 375,000 ha). Smallholder farmers consist of small farmers (1.0–2.0 ha of farmland) and marginal farmers (less than 1.0 ha). The farmers were fed with mini water shed – tank cascade systems, rainfed irrigation and stand-alone irrigation systems.

Components of the project

The interventions identified as relevant to this study are as follows:

i. Promote Climate-Resilient Agricultural Systems: The objective of this component is to enhance climate resilience beyond farm gate and provide integrated end-to-end solutions in selected commodity value chains. This component will focus on small holder inclusive value chains, technology adoption, agricultural weather insurance, strengthening producer groups and improving food safety and nutrition security.
ii. Enhance Climate-Resilient Value Chain Development: The objective of this intervention is to build climate-resilience in agricultural production systems through a series of activities at farm level, complemented by interventions in mini watershed areas. This component will focus on improved physical infrastructure, climate-resilient agricultural practices, and emergency response.
iii. Institutional Development, Knowledge and Capacities: The objective of this component is to ensure sustainability in the approach of building climate resilience through a long-term adaptive management of agriculture, soil and water resources through improving the capacity of existing institutions (World Bank, 2019)

Transformative Adaptation Options

There are a few transformative adaptation options were identified in this project.

Developing Farmer Producer Societies (Producer Farmer Organization) with an aim to commercialize agriculture was one of the major transformative adaptation options employed by the project. This

intervention included strengthening the link between producer groups and agriculture markets. Marketing arrangements have been made through the Department of Agriculture to sell the production as certified seeds. Information and communication Technology (ICT) units in selected ASCs facilitated providing real time marketing information. These innovations will promote the diversification from food grains into climate-adaptive, higher-value agriculture crops. The producer societies are expected to enhance the productivity, reduce the cost of production, and thereby increase the profitability. The activities will result in more efficient water use and CSA practices.

Five agriculture programs (Cluster Village Development, COVID-19 Yala, Climate Smart Nutritional Sensitive Home Garden, Mid-Season Cultivation and Maha Season) have launched in line with the national policies of the Ministry of Agriculture. People under lockdown situation were able to attend fulltime in agriculture thus improving productivity thereby increasing the household income.

Another transformative adaptation option was to be initiating the amendments to the current Agrarian Development Act of 2000 to strengthen the FOs and to establish cascade-level farmer organizations by the DAD. The proposed amendments will empower the community to conserve their natural resource base and management of water resources in collaboration with central/provincial governments. As this is an action by th DAD, the CSIAP's specific input to this activity should be further studied.

The environmental activities include the actions to minimize human-elephant conflict through innovations sch as seasonal elephant fences.

The project took steps to improve women's participation in decision making related to natural resources. CSIAP Social Security Team addressed distresses in the families focusing women. There was a significant involvement in home gardening by women and improvement in their access to agriculture extension and ICT in agriculture. The project facilitated gender empowerment in marginalized small holder farming communities.

The Project promoted sprinkler and drip irrigation. The Project has carried out Hydrological Assessments in three River Basins as pilot programs (Mandakal Aru, Yan Oya and Mi Oya basins) to study the potential of augmenting irrigation water supply in the commands and catchments of cascade tanks. This is another novel approach which has not been attempted during conventional village irrigation rehabilitation.

Involvement of the beneficiaries in planning specific interventions during the implementation period was ensured through participatory rural appraisal methods. Beneficiary participation was also ensured through the "Preliminary Investigation Report" (PIR) process to identify irrigation system upgrading priorities.

Institutional mapping: Institutions involved in planning, implementation, M & E and their responsibilities CSIAP

Sector	Institution	Planning	Implementation	M & E	Responsibilities
Agriculture & Livestock	Ministry of Agriculture	Yes	Yes	Yes	Project implementation
	Ministry of Livestock Development	Yes	Yes	No	Project implementation
	Ministry of Fisheries & Aquatic Resources	Yes	Yes	No	Project implementation
	Dept. of Agriculture	Yes	Yes	Yes	Expert Knowledge
	Provincial Departments of Agriculture (PDOA)	No	Yes	Yes	Agriculture extension
	Dept of Agrarian Development (DAD)	Yes	Yes	Yes	Expert Knowledge, implementation of specific activities
Administrative/ Rural development	The Department of Project Management and Monitoring	Yes	No	Yes	Monitor the project activities and submit quarterly progress reports to Cabinet of Ministers
	Provincial Councils	No	Yes	No	Project implementation
	Divisional Secretary	No	Yes	No	Project implementation
	Grama Nilandhari (GN)	No	Yes	No	Project implementation
Water (Includes irrigation)	Ministry of Mahaweli Development and Environment[9]	Yes	Yes	Yes	Project implementation
	Mahaweli Authority of Sri Lanka	No	Yes	No	Liaison
	Ministry of Irrigation and Water Resources Management[10]	Yes	No	No	Project implementation
	Irrigation Department	Yes	Yes	Yes	Expert Knowledge
	Provincial Irrigation Departments	Yes	Yes	Yes	Assisting in management and operation of the project, monitoring and evaluation
	Provincial Councils	No	Yes	No	Project implementation
	Divisional Secretary	No	Yes	No	Project implementation
	Grama Nilandhari (GN)	No	Yes	No	Project implementation

9 At present Mahaweli Development subject is absorbed to the Ministry of Irrigation, while there is a separate Ministry of environment.

10 Currently, the Ministry of Irrigation

Financial management institutions/ banks	Ministry of Finance	Yes	Yes	Yes	Project implementation
		Yes	Yes	Yes	Assisting day-to-day management and operation of the project
Private sector	Consultancy firms, Civil works contractors, agricultural machinery	No	Yes	No	Expert Knowledge, services
WUA/FO leaders	Farmer Organizations, Women groups, Rural Development Societies (RDS), Women's RDSS, Women FOs	No	Yes	Yes	Beneficiary and the project implementation
Farmers	Already represented by FOs	No	Yes	Yes	Beneficiary and the project implementation
Marketing institutions	Exporters, Medium and large scale industries for value addition	No	Yes	No	Expert Knowledge, implementation
Insurance companies/Institutions	Agriculture and Agrarian Insurance Board	No	Yes	No	

Annex A4. Northwestern Province canal project (NWPCP)

Why this adaptation option?

Droughts and floods are the major climate impacts in Northwestern Province (NWP) due to high temperature and rainfall fluctuations. These disasters damage agriculture, and impacts human health, and the economies in the province. The NWP region has 2,592,000 million people, and most of them live in rural areas. NWP is high-risk areas for chronic kidney disease of unknown etiology (CKDu). The cause of CKDu may be due to lack of safe drinking (DOA, 2006). CKDU is a major burden on the healthcare system of the NWP in particular, and of the country in general (Samarakoon et al 2013).

The NWPCP aimed to increase the cropping intensity of existing cultivated lands under major and minor irrigation schemes and provide safe drinking water to a large population of the NWP with high risk of droughts and CKDu risk (MMDE, 2018).

Brief Description of NWPCP

The NWPCP areas include Hakwatuna Oya Irrigation System in the Deduru Oya River Basin and medium and small irrigation systems in the Upper Mi Oya Basin in the Northwestern Province (NWP). The project implemented in two stages, first transfer 100 million m^3 of Mahaweli water to Dambulu Oya, and then transfer water through a 91 km conveyance canal to the two reservoirs Mahakithula and Mahakirula located in the Kahalla-Pallekele forest reserve.

Main activities/sub-activities

1. The NWPCP, focused on following the three major activities: Augmentation of the existing cascades (including more than 300 minor tanks and 8 major tanks) by transferring Mahaweli water to the northwest.
2. Irrigation of more than 12,000 hectares of land for agriculture in both Yala and Maha seasons.
3. Facilitation of access by the local people to safe drinking water to minimize the occurrence of chronic kidney disease (CKDu).

NWPC originates at Lenadora in Mathale District, approximately 1 km downstream from the Bowatenna tunnel outlet. Transfer canal supply water to Wemedilla and then to Dewahuwa reservoirs. The transfer canal goes through the Kahalla Pallekele Sanctuary in Kurunegala District, and Maha Kirula and Maha Kitula Reservoirs which serve as storage reservoirs. The Mahakithula reservoir enable the transfer of water to Hakwatuna Oya Reservoir. The diverted water stored in the two reservoirs existing and new reservoirs in the Kurunegala District and distributed to tanks in the Hakwatuna Oya Basin and Upper Mi Oya basin according to irrigation and drinking water demands benefitting 80,000 families in 393 Grama Niladhari (GN) Divisions located in 7 Divisional Secretary Divisions.

Institutional mapping: Institutions involved in planning, implementation, M & E, NWPCP

Sector	Institution	Planning	Implementation[11]	M & E
Agriculture	Dept. of Agriculture	No	Yes	No
	Dept of Agrarian development (DAD)	No	Yes	Yes
Water (Includes irrigation)	Department of Agrarian Development	Yes	Yes	Yes
	Ministry of Irrigation	Yes	Yes	Yes
	Provincial Irrigation Departments (NWP)	No	Yes	No
	Mahaweli Authority of Sri Lanka	Yes	Yes	Yes
	Irrigation Department (ID)	Yes	Yes	Yes
	Disaster Management Center	Yes	Yes	yes
Climate services	Department of Meteorology	Yes	Yes	
Environment and Forest Sector	Forest Department	Yes	Yes	No
	Department of Wildlife conservation	No	Yes	Yes
	Ministry of Environment	Yes	Yes	No
	Regional Forest Office (RFO), Galewela Office	No	No	Yes
	Central Environment Authority	Yes	Yes	Yes
	Wayamba Environmental Authority	Yes	Yes	No
Donors	Asian Development Bank (ADB)	Yes	Yes	Yes
NGOs/COs	Civil Society Organizations (CSO)/NGO	No	Yes	No
Financial management institutions/ banks	Ministry of Finance (NPD, ERD, PMD)	Yes	Yes	Yes
Private sector	Technical consultancy firms - Mahaweli Consultancy Bureau (Pvt) Limited, NEM Construction (Pvt) Ltd , China State Construction Engineering Corporation Limited, External monitors,	No	Yes	No
Universities/ educational institutions	University of Wayamba			
Land Management	Survey Department, Valuation Department, District Secretary	Yes	Yes	Yes
Insurance companies				
Service providers	Consultancy firms	No	Yes	Yes
WUA/FO leaders	Farmer Organizations	No	Yes	Yes
Farmers				

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Marketing institutions	.	No	No	No
Customary/traditional	Department of Archeology		Yes	
Price control				
Trade regimes				
Social and safety nets	District Secretariat, Divisional Secretary, Pradeshiya Sabha, GN	No	Yes	Yes

Sources: MMDE, 2014

Roles and responsibilities

Institution	Roles and responsibilities
ADB	Funds disbursement, M&E
MOF	Funds disbursement to MOI, M&E at National level
MOI and ID	Project implementation, Fund disbursement, Coordination with government entities, M&E, Implementing Grievance Redress Mechanism (GRM)
ME (CEA, FD, DWC)	Environmental Risk Management, Environmental Impact Assessment (EIA), Preparation Environment monitoring Reports.
MASL	Providing technical support and Guidance, M&E, GRM
DAD	Dissemination of advisories for better water management, Holding seasonal cultivation meetings,
PDOA	Agriculture extension when village irrigation sub component starts
DoA	Climate Smart Agriculture guidelines
FD	Environmental Impact Assessment (EIA), preparation Environment monitoring reports and Inspections.
DWC	Establishment of Hakwatunawewa Elephant Corridor, Make Wildlife Management Plan, Human Elephant Conflict Management and Mitigation.
CEA	Environmental Impact Assessment (EIA), preparation Environment monitoring reports, Establishment of Hakwatunawewa Elephant Corrido.
STC	Extraction of Timber from Forests and conversion of timber.
MLLD	Implementing of National Involuntary Resettlement Policy in collaboration with network of public and CSOs and Land Acquisition assessment.
Survey Department	Topographical data for land management
VD	Preparation of valuations for the payment of compensation for the private lands and Land Acquisition assessment
PID	Selection of VIS for rehabilitation
District Secretariat	District-level coordination, DAC
Divisional Secretariats -	Divisional-level coordination, Supporting GRM.
CSO/NGO	Monitoring environmental issues
Private sector	civil works contractors, multi-disciplinary consultancy services.
Universities/ academia	Provision of technological services