COMBATING CLIMATE CHANGE AND ACHIEVING SDGS THROUGH INTEGRATED WATERSHED MANAGEMENT (IWM): LESSONS FROM INDIA

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Abstract:

Integrated Watershed Management (IWM) focuses on the management of a watershed at the local level using a holistic, multi-stakeholder, and multidisciplinary approach. This extends past the hydrological conditions and understands the interconnectedness of IWM as a socioeconomic and political unit. India's watershed management has demonstrated a continual evolution of managerial practices from top-down and engineering to participatory and integrated approach. This paper highlights the evolution of practices within India's IWM, issue, and challenges, its potential to combat climate change and contribute to the SDGs. In Spite of an impressive evolution and impact at the local level, the sector still lacks basin perspective in planning and designing watershed interventions at the micro/meso level. Though convergence policy was adopted long time back, alignment of policies and institutions from the central to the district level is still a big challenge. Further, sustainability of the infrastructure and institutions created at the local level is also a big issue in Indian IWM initiatives. Subsequent lessons learned involve inside out planning and use of pre-existing social structures rather than always creating new ones which could increase local ownership and participation, sustainability and adaptive capacity of local villages.

Keywords: Watershed Management, SDG, Climate Change, Sustainability, Community Participation, Convergence, Inside out planning

1 Introduction

"Efficient watershed management will help increase agricultural production in rainfed areas, lead to better use of scarce water resources and raise household incomes of farmers"

- Onno Ruhl, World Bank Country Director for India.

On January 14, 2016, a $178 million (US) deal was signed between the World Bank and the government of India for the Neeranchal National Watershed Project. The intended goal is to improve watershed management in rural rainfed areas that cover 400 sub-watersheds - about 5,000 ha each - and reach approximately 482,000 farmer households and two million people (The World Bank, 2016).

India's long history of the hydrological cycle was recorded in Sanskrit literature which highlighted the causes of rainfall, phases of the water cycle, and methods to identify groundwater. The first mention of watershed management can be traced to the Atharva Veda (800 B.C.) in verse 19, 2.1: "...one should take proper managerial action to use and conserve water from mountains, wells, rivers and also rainwater for use in drinking, agriculture,

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industries" (Chandra, 1990). India's management of water resources continued through the earliest recorded watershed management initiative in 1888 to protect ravines from water erosion, during colonial administration. While the methods of water management have evolved, the importance of water and watershed management within India has remained through to the 21st century as demonstrated by the recent deal with the World Bank.

As defined by Easter (p. 4 1985) "The watershed is a functional region that includes the key interrelationships and interdependencies of concern for land and water management." It consists of a main river or flow of water and incorporates all streams, run-offs, and rivers that flow into it. They also consist of all the surfaces that are within the boundary or basin. Watersheds take into account both terrestrial and sub-terrestrial water. The watershed is the system of water that provides communities within its boundaries access to water for drinking, cleaning, cooking, irrigation and any other required use.

India's history of watershed management has the potential to provide global best practices and wisdom for an integrated, participatory and holistic approach. The government's previous history included a top-down, non-basin approach which involved governmental policy and little participation of communities. The evolution towards the current integrated watershed management (IWM) demonstrates the transition to provide community participation that can meet the needs of those at the village level. The continued growth and expansion of IWM to providing a meso level, community approach has the potential to support in the mitigation of climate change and help in the achievement of the UN 2015 Sustainable Development Goals (SDGs). The SDGs are 17 goals put forth by the UN to end poverty, protect the planet and provide prosperity for all with the intention to be completed by 2030 (UN, 2015).

Through current research, climate change is increasing uncertainties within watershed basins as extreme events such as drought, flood and desertification become more prevalent through changes in the hydrological cycle and temperature. These fluctuations impact social, ecological, economic and cultural services of a watershed. In the case of India, rural communities lack the capacity to adapt to increasing uncertainties within climate change. The implications of climate change must be incorporated within Integrated Watershed Management (IWM). Expanding IWM will increase the resilience of communities facing the adverse effects of climate change and help in the achievement of SDGs. This paper will explore what lessons can be learned from India including:

> **How can governments and communities utilize an Integrated Watershed Management (IWM) approach to adapt with the impact of climate change in India and contribute to Sustainable Development Goals?**

This paper will investigate the history, evolution, and current practices of integrated watershed management in India in the wake of increasing climate change impacts on water and livelihoods in the context of achieving the SDGs. This research paper is divided into 6 sections; section 1, 2 and 3 focus on the theoretical aspects of watershed management and methodology, current watershed policies, institutions and practices in India will be presented

in section 3, analysis of an Indian case study in terms of its relation to contributing to SDGs and combating climate change, policy approach, implementation and sustainability will be presented in section 4, based on the inference from section 2, 3 and 4, the lessons learned (positive or suggestions for further improvement) will be presented in section 5.

2 Integrated Water Resources Management (IWRM)

The term Integrated Water Resource Management (IWRM) stemmed from the Dublin conference on Water and the Environment in January 1992 (ICWE, 1992). From this conference, the world's view of water resources shifted towards a more integrated approach, away from the siloed and disorganized attempts to solving the issues around the resource. IWRM is seen as the world's response to the global water crisis, affecting large portions of this planet. IWRM is a tool to accomplishing the SDGs and has a more global context in regards to policy and intervention (Butterworth, 2004). IWRM focuses on a wider perspective, it does not consider hydrological boundaries in many ways but looks more at the macro level of the resource of water in a country and the policies that govern its management. IWRM is the underlying framework used to inform country interventions and policy changes at the national level.

Watershed Management is a more localized intervention and "is resource management with the watershed as the basic organizing unit" (Wang, 2016). Integration of Watershed Management (IWM) is the management of the watershed used to achieve IWRM principles, taking into account other aspects beyond solely water such as soils, forests, wildlife, land uses and water uses. IWM is watershed management using a holistic, multi-stakeholder, multi-disciplinary approach (German et al. 2007). It is the management of a watershed, focused specifically on one particular watershed, regardless of scale.

"Integrated watershed management grapples with the complexity of interactions between ecosystems and socio-economic systems, and aims to restore and sustain the health, productivity, and biodiversity of ecosystems through strategies that integrate the needs of society and the economy" (Wang, 2016). Put differently, the focus is on a more integrated approach taking into account all relevant stakeholders, land, and water use, and the conservation of water flow from upstream to downstream. A key principle is incorporating people and communities, not only in the decision making of how to manage the watershed but also in the implementation and fulfillment of tasks and duties around the continued managing of the watershed. Another key aspect of IWM is to focus on the local scale with emphasis on individual communities and then gradually expand the scope of the projects to incorporate larger areas (Dargouth, 2008).

IWM strategies are implemented to provide resilience to communities that otherwise are left to the will of nature. IWM improves livelihoods of local community members as it brings more reliable farming and stable water supplies (Reddy, 2014). Ensuring livelihoods increases the demand for a reliable water supply, which makes the integration of community members all the more important and vital for the successful conservation of the watershed. IWM also promotes community engagement at its core with community involvement in project ideation,

livelihood is at the forefront of decision making and planning. Community members are the decision makers when it comes to water uses, flow, and conservation. According to Pandit (2007), when community members are at the forefront of decision-making, the effects on their livelihoods are greatly improved.

2.1 Impact of Climate Change on Watershed functions

Climate change affects air temperature and precipitation levels all around the world yet the specific degree to which these elements are affected is increasingly unpredictable (Misra, 2014). Watersheds, much like all forms of water on this planet, are greatly impacted by climate change. Unpredictable rainfall leads to unpredictable water supply in the watershed. Without proper management, this can lead to long periods of drought and flooding. Watersheds provide communities and larger regions with not only drinking water supply but water for irrigation and food production, sanitation and other aspects of daily life. With unpredictable water resources, watershed functions shut down, and everyone suffers (Misra, 2014). The variability in weather, caused by climate change, impacts the ecosystem and the services it provides further affecting community members (Misra, 2014).

2.2 Importance of IWM for adaptation to Climate Change and SDGs

The lack of control over the climate focuses attention on the control of other variables in order to mitigate effects of climate change. In our view, IWM is the best solution for increasing resilience within communities, providing the means to survive the fluctuating climate and all the negative implications along with it. The integrated approach to IWM ensures that all aspects of the local community, all stakeholders, are taken equitably into consideration and actions are taken accordingly. Climate change affects more than just the the blue water (in terms of rainfall and water table levels) it also affects the green water (soil moisture that is used directly by plants). Green water directly impacts the blue water availability of the watershed by transpiring a significant amount of blue water. This green water often goes largely unaccounted for causing mismanagement of watersheds, which ends up exacerbating the impacts of climate change on the watershed and communities. Green water, therefore, has a crucial role to play in the planning and mitigation of the watershed for climate change effects. (Rockstrom, 2010)

The SDGs which are an extension from the Millennium Development Goals (MDGs) (2000-2015), established targets and indicators to influence action towards many of the challenges facing our world today. Goal 6 in particular focuses on clean water and sanitation, with targets including supporting and strengthening the participation of local communities in improving water and sanitation management, increasing water-use efficiency and ensuring sustainable withdrawals and supply of freshwater in order to address scarcity, as well as implementing IWRM at all levels, including through transboundary cooperation as appropriate. (United Nations, 2015) With these targets at the forefront of the goal, it is clear that IWM must play a vital role in achieving it. Beyond goal 6, there are other goals that IWM principles address as well including: goal 1 - No Poverty; goal 3 - Good Health and Well-Being; goal 13 - Climate Action; and goal 15 - Life on Land. IWM realizes the relationship between land and water,

knowing the complexities and interdependencies they have on one another. This understanding ensures land and forest protection which act as carbon sinks to offset climate change. The security of land and forests also protect the natural water flows and ensure a safer and more reliable supply (Thaxton et al. 2015).

3 Theoretical Framework

The watershed is a geographical area defined by natural hydrological boundaries where precipitation, through partition at different levels, eventually concentrates in a particular location such as a river or lake (Lal, 1999). The watershed is also a geographical area where people and communities interact with a complex array of resources such as soil, water, minerals and biotas (Tecle et al, 2003). Moreover, Easter et al. (1985) define the watershed not only as a hydrological unit but also as a social, economic, environmental and political unit.

Degradation of a watershed is caused by a change in the farming system, deforestation, overgrazing, unplanned road construction and several other human activities in developing countries. This has serious implication not only on the stock of natural resources but also on the livelihoods of the people in the area, which further exacerbates the degradation of the watershed. The causes and effects of degradation of a watershed are highly intertwined. For example, streams are drying up in Yemen because of overexploitation of groundwater table for market-oriented agriculture and the drying of streams has several social, environmental and economic impacts on communities (Darghouth, Ward, Gambarelli, Styger, & Roux, 2008). Recognizing the complex human interaction with the watershed, governments, and development organizations have changed their focus from an engineering solutions approach to an integrated action on conservation, people, and livelihoods. IWM combines technical, socio-economic and ecological perspectives from the intervention design to the implementation. Balancing all these perspectives is a daunting task and more often leads to confusion among stakeholders because of conflicting and overarching objectives such as conservation and economic development.

Figure 1 demonstrates the linkage of IWM initiatives with social (people and local institutions), physical (infrastructure), human (empowerment-education, health and skills), financial (cash inflow and outflow at the household and community levels) and natural resource capital (common, pooled resources) at the local level (Reddy, 2014). IWM initiatives will increase all five of these capitals which will eventually increase the resilience of communities against climate change. As depicted in Figure 1, the outcomes of the watershed management activities are usually defined by the combined effects of policy and legislation, institutions and implementation, the participation of the community and the economics of interventions. Utilizing the framework presented in Figure 1, this paper analyses policies, institutions, and practices of Indian watershed management initiatives and presents the positives and challenges associated with it, and look into the ways through which IWM increases resilience and contribute to the SDGs.

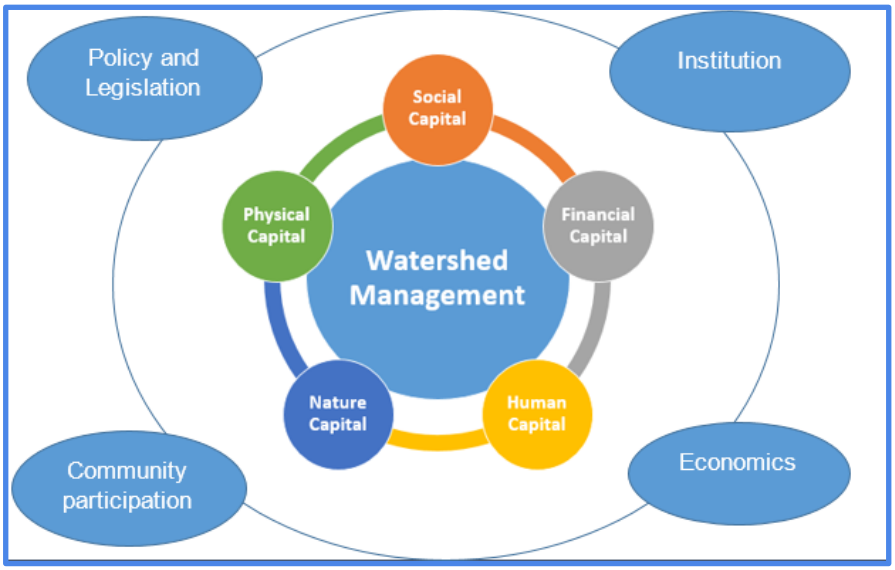

Figure 1: Watershed Management - Resilience Model [adapted from **Reddy, 2014 and Vishnudas, Savenije & Van Der Zaag, 2005***]*

4 Overview of Watershed Management in India

"India is poor because rural India is poor and Rural India is poor because the farmer living in the rural area is poor". -Mahatma Gandhi. (Kakade & Hegde, 1998)

The total geographical area of India is about 328.7 million hectares. Around 40% or 142 million hectares of the total arable land is irrigated while the remaining 85 million hectares still depend on rainfall. This equates to roughly 2% of the world's geographical area being rainfed-dominated agriculture which is used to feed 18% of the world's human population and 15% of the world's livestock population (Government of India, n.d). With the increase in population, the arable land per capita has decreased from 0.34 ha in 1961 to 0.12 ha in 2014 (The World Bank, 2014). Climate change will exacerbate the population stress on land, water and other natural resources in India. Climate change, in terms of extended time and frequency of extreme events, will also have negative impacts on the agriculture industry in India, which accounts for 58% of the population's livelihood. The rising temperature and extreme weather events will cause increased water storage, due to Himalayan glacier melt, as well as an increase in demand for other purposes. Coastal inhabitants will also be affected by any rise in sea level due to changes in climate. All impacts will be synergistic and result in cumulative negative impacts on food and water security in India (Lok Sabha Secretariat, 2013). Resources have to be managed at the local level by building ecosystem resilience via increasing water availability and reducing land degradation. Watersheds have been an integral part of government policy since the 1970s in combating resource degradation because of human activities and climate change. The following section and subsection will describe different aspects of Watershed Management in India from history and evolution, to current implementation, practice and impact at the local

level.

4.1 History of Watershed Initiatives

Watershed management in India has undergone multiple transformations during the past one hundred years of history. The transformative changes are found in centralization to decentralization, more government to less government, and a singular objective (technical solutions) to a multiple objectives (social, economic, natural resource conservation and empowerment) approach. Soil and water conservation have always been a focus even during the colonial administrative government of India and after independence in the 1950s.

The central government implemented fragmented watershed activities in the 1950s and introduced the first major program called River Valley Project Scheme (Vania & Taneja, 2004 & Joshi et. al, 2004). The 'green revolution'; i.e the period when the productivity of agriculture drastically increased in India, started in the 1960s and altered the focus of watershed activities. Early programs in the 1970s focused on technical interventions to promote soil and water conservation measures, agriculture productivity in drought-prone areas and the installation of water-harvesting structures. This was implemented by the Ministry of Rural Development (MoRD) which included the Drought Prone Areas Programme (DPAP), the Desert Development Programme (DDP) and the Integrated Wasteland Development Programme (IWDP). Gray & Srinidhi (2013) found that these initiatives increased agricultural yield but also increased inequality between landowning and non-land owning households.

A major shift took place in the 1990s after non-governmental organizations became more active, under both post-Cold War pressures of donor agencies pressing for enhanced civil society involvement and a shifting global governance approach (IWRM). The Project Implementation Agency (PIA) and various donor agencies such as bilateral programs involving actors such as the World Bank and the German government initiated several projects. Involvement of non-state actors provided an opportunity to test new ideas and approaches. For instance, the Indo-German Watershed Development Program (IGWDP) promoted a participatory approach which focused on livelihood and community mobilization developed by the Watershed Organization Trust (WOTR) (Gray & Srinidhi, 2013).

Another transformative activity within Indian watershed development was the Guidelines Development in 1994 and subsequent revisions. This was a move towards process and system development for watershed activities and moving towards a more transparent system. The Integrated Watershed Management Program initiated by the government in 2009 was a major step towards an integrated and holistic framework. As presented in Figure 2, the Indian initiatives within watershed management have progressively transitioned towards a more participatory, social, livelihood and ecosystem focus. However, watershed projects are distributed among different government institutions and forest and ecological perspectives are often neglected. The following subsections will further explore policy institutional and implementation aspects of watershed management within India.

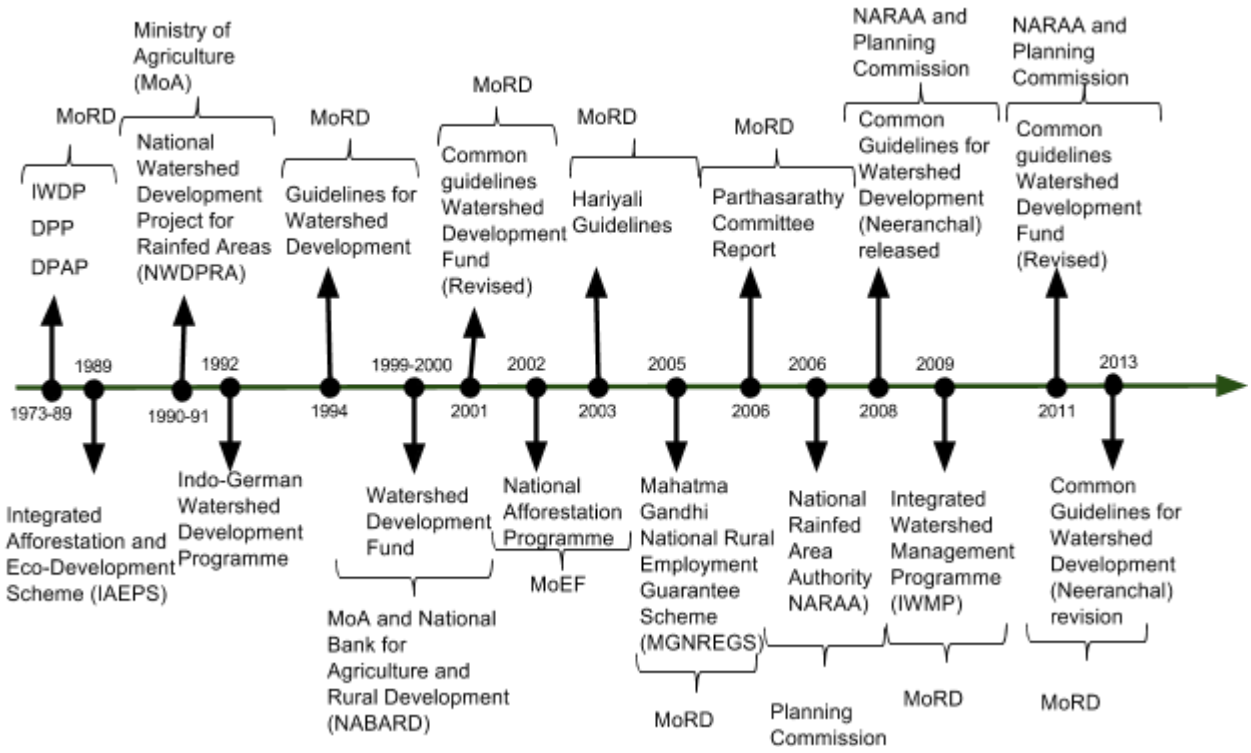

Figure 2: Timeline of Major Events in Watershed Development in India (adopted from Gray & Srinidhi, 2013)

4.2 Watershed Development Policy and Guidelines

According to Wani, Rockström, & Sahrawat (2011), watersheds are influenced by a range of factors beyond rainfall: e.g., agriculture and other forms of land use, water management, existence and changes in forest cover and other natural resources. Agriculture development, land, and forest policy support watershed programs that are consistent with watershed development programs. Until the 1990s, the Indian government's policy on watershed management was mainly focused on soil conservation and agriculture productivity. The focus shifted towards a more holistic, integrated framework by 1995. The government introduced the first watershed development guidelines in 1995 which brought coherency and consistency among watershed projects and programs implemented by different government and non-government agencies. The guidelines provided a common set of operational rules, objectives, funding norms, and strategies for watershed projects. Moreover, the guidelines established micro-watersheds (watershed with area 500 - 100 hectare) within the integrated watershed planning and development (Symle et.al, 2014). The activities and other provisions envisioned in the guidelines recognized the fact that the watershed is not only a biophysical but also a socio-economic and political unit.

The objective of the 1995 guideline was to promote the economic development of village communities, improve livelihoods, and encourage ecological restoration. These objectives were expanded in 2001 to include, for example, mitigation of extreme climatic conditions, rehabilitation of marginal and degraded lands, long run sustainability,

empowerment, use of simple and affordable technical solutions/local knowledge, employment generation and poverty alleviation. The guideline was further revised in 2012 where groundwater was included in the objective and included climate change adaptation strategies, land productivity, sustainable livelihoods especially for smallholders, empowering local people and institutions (Symle et al, 2014). Unlike previous guidelines, the revised guidelines in 2012, consider larger watersheds, i.e. those with an area between 3,000 to 7,000 ha and/or having additional contiguous watersheds but for hilly regions, small sizes were considered for implementation (Symle et.al, 2014). The 2012 guidelines also provided the basis for selecting watershed areas for implementation wherein the extent of water-related problems such as scarcity of drinking water, unirrigated land, degraded land, groundwater recharge, and productivity potentials and social contexts such as demographics of population, incidence of seasonal or long-term distress, out-migration, and link to another watershed were considered. However, water related criteria were given higher weight than the social context in the selection process.Following are other key process and provisions set by guidelines revised in 2012:

- The fund allocation is determined by the Nodal Ministry/Department which will transfer the fund to the State Level Nodal Agency (SLNA) based upon the request. Upon receiving the request along with appropriate documentation from District level institutions, SLNA transfer funds to them which will reach communities through Watershed Cell cum Data Center and PIAs (Symle et al, 2014).
- The project duration for watershed activities is set at 5 years, the preparatory phase is allocated for 18 months; 3 years for watershed works phase and 6 months for consolidation/withdrawal (Symle et al, 2014).
- The Maximum amount of funding from the government is limited to Rs 12,000/ha (approx. $193.4 in 2017 dollars). The guideline has specifically set the distribution of funds in terms of project activities. 55% of the total funds received shall be used for watershed development works, 16% for livelihood, 16% for institution development and capacity building, 5% for administrative expenses and remaining 9% for entry point activities, detailed project and monitoring evaluation and learning (Symle et al, 2014).
- The cost sharing for communities and individuals who participate in the project is set at 10% for private land and 5% for Scheduled Caste (SC) and Scheduled Tribes (ST) for Natural resource management works whereas it is set at 20% and 10% respectively for SC and ST for Aquaculture, horticulture, agroforestry, and animal husbandry (Symle et al, 2014).

4.3 Institutional Structure

The institutional structure for implementation of integrated watershed management projects and programs is a 4-5 level system which comprises of Central Level Nodal Agencies (CLNA), State Level Nodal Agencies, Regional Level Agencies (some states exempt), District Level Nodal Agencies and watershed Level. Every state contains a CLNA; however, the district and watershed level structure changes from state to state and even project to project. Overall, the structure has to be in line with the common guidelines (see section 1.4). The function of the

institutions at each level are presented in the table below:

Table 1: Watershed Institution and their roles and responsibilities (Wani, Rockström & Sahrawat, 2011)

Level	Roles and Responsibility
National level	• National Rainfed Area Authority (NRAA) supports the strategic planning, and coordination between agencies and departments that are involved in the watershed. • MoRD and Department of Land Resources (DoLR) facilitate implementation of the project / program. They are responsible for designing policy, budgetary allocation, interact with state, regional and district level agencies and ensure smooth flow of funds as per the recommendation from SLNA.
State level	• SLNA constitutes state government agencies / department • SLNA prepares strategic plans for states, coordinate with central government, approve watershed projects for the state on the basis of set guidelines etc.
Regional Level	• Regional Level institutions do not exist in some states. • The function of regional level agencies is to coordinate with SLNA and facilitate project implementation through district level institutions.
District Level	
District Watershed Development Unit (DWDU)	• Oversees the implementation of watershed programs in each district • Separate independent financial accounts for this purpose • Responsible for identifying potential PIAs in consultation with SLNA as per the process as decided by the state governments • Facilitate coordination with other relevant programs and department.
Project Implementing agencies (PIA)	• PIAs may include relevant line departments, autonomous organizations under State/Central governments, government institutes/research bodies, and voluntary organizations (VOs). • Responsible for implementation of watershed projects in different districts - Providing services in the areas of awareness generation, capacity building, information, education & communication & social audit, among others • PIAs must demonstrate eligibility based on experience, technical

	& financial capacity, antecedents etc
Watershed Level	
Watershed Committee	• Consists of 10-12 Member [half of them are from SHGs and UGs+ member from castes (SC) or scheduled tribes (ST)+ women and landless] • Manages the project funds, coordinates and liaises with Gram Panchayat, Project Implementing Agency (PIA), Watershed Development Team (WDT) and other agencies
Self- Help Groups (SHGs)	• Mainly consist of landless individual with common or similar source of income such as Women's group • Primary activity is run saving and credit facility (revolving fund) from the set amount provided the nodal Ministry • Loans from revolving funds act as an income generating activity
User Groups (UGs)	• UGs are also the beneficiaries • Groups are formed around specific interventions • Created by the project in collaboration with Gram Panchayat (elected local bodies in a village) • Responsible for operation and maintenance of all the watershed institution and infrastructure.

With reference to Table 1, User Groups are formed around specific interventions so that there might be more than one user group in a particular watershed area. The institutional structure is unidirectional (top - down) and heavily bureaucratic in nature. The 2012 guideline is open to any kind of institution whether it is government or non-government for PIAs.

4.4 Integrated Watershed Management Program

Over time, the watershed program has transitioned in terms of type, number, focus, and approach. The Desert Development Program (DDP), Integrated Wasteland Development Program (IWDP) and Drought Prone Areas Program (DPAP) are three early programs initiated in the 1970s by the government of India. They focused on the control of drought and desertification, developing wasteland in non-forest areas to control land degradation, promoting sustainable use of resources, minimizing the adverse effects of drought on agriculture production through technical interventions, and promoting the overall economic development of poor and marginalized local communities (Government of India, 2011).

In 2007-08, government of India amalgamated all watershed related projects mainly DDP, DPAP, and IWDP and formed a single program called Integrated Watershed Management Program (IWMP). Since 2009-10 until 2014-15, all watershed projects were sanctioned under

IWMP. Until 2014, around 7204 projects were completed which covers around 34.264 million ha with central government contributing 87.4 billion Rs. The project followed the common guideline for implementation of the projects (Government of India, n.d).

IWMP was included as Watershed Development Component under Pradhan Mantri Krishi Sinchayee Yojana (WDC – PMKSY), known as Prime Minister agriculture irrigation project, since 2015-16. WDC-PMKSY is the combination of Accelerated Irrigation Benefit Program and PMKSY (WR) of Ministry of Water Resource; IWMP, Ministry of Rural Development, and Minor Irrigation Component of ON Farm Water Management of National Mission on Sustainable agriculture. Though the structure of the program remained the same, as it is still administered by Ministry of Rural Development and Department of Land Resource, the nodal ministry for the whole program is now Ministry of Agriculture and Department of Agriculture and Cooperation (Government of India, n.d).

4.5 Projects and Program Management

Typical project duration for watershed activities is set for five years. Watershed project implementation is mainly categorized in three phases, i.e preparatory phase, watershed works and consolidation phase. Typically the preparatory phase is allocated for 18 months, 3 years for the watershed works phase and 6 months for consolidation/withdrawal (Symle et.al, 2014).

The preparatory phase includes entry point activities which will assist watershed development teams and project implementing agencies (PIA) to build rapport with people and communities. This phase also includes the development of village level institutions such as WC, SHG and UG, conduct baseline surveys that include socio-economic study, hydro-geological survey, awareness building, understanding and prioritizing the interest, perceptions and priorities of women, marginalized caste, indigenous communities and landless, and preparing detailed resource user agreements among user group members based on equity and sustainability. The outcome of the preparatory phase is a Detailed Project Report (DPR) which will elaborate the “who, what, why, and how” questions in general. The guidelines stressed in strong participatory rural appraisal exercise and comprehensive data collection by PIA. The DPR needs to be approved by local government institutions called “Gram Sabha” and then submitted to the district level institutions for approval.

Ridge area treatment work is scheduled to be the first watershed related intervention in selected areas which is aimed to reduce the volume and velocity of surface runoff and generation of vegetation covers. However, it also includes a range of much other water, land, agriculture and income related activities. Consolidated and withdrawal phase includes post project capacity building and carrying out the new agenda of sustainable natural resource management and upscaling successful interventions (Government of India, 2011).

4.6 Impact of IWM

The impact of IWM has been widely documented by the government of India in various reports including cumulative impacts from Meta-Analysis to Assess Impact of Watershed Programs and People’s Participation (Joshi et al. 2008), WDP Impact Assessment- NIRD (2010),

and Comprehensive Study of Impact of Investment in Watershed Project (Sharma et .al, 2012). Most of the reports have similar claims with regard to the impact of watershed interventions on natural resources, crop production, groundwater increase, runoff, economic sustainability, institutions, and technology.

The "Comprehensive Study of Impacts of Investments in Watershed Projects" studied 947 completed watershed projects that included 444 watersheds under DPAP, 321 under DDP and 182 under IWDP spread over 169 districts in 17 states. In all, 444 watersheds under DPAP, 321 under DDP and 182 under IWDP were considered for the study. Fifteen nodal agencies produced the necessary data through direct survey, focus group discussion, PIA and district level officials on included entry point activities, HRD activities, training and capacity building, NRM (SMC works, WHSs, plantation) crop demonstration, production systems and use of revolving fund (Sharma et .al, 2012). The comprehensive assessment affirms the following impacts of Watershed projects:

i. **Natural Resource Conservation (**Sharma et .al, 2012**)**
   - o About 5 % additional area was brought under cultivation.
   - o About 9 % additional increase in irrigated area.
   - o Increase in common property resources such as 7.6 million hectares is believed to be vegetated by IWMP and increase in fodder and fuelwood availability.
   - o On an average, 40 watershed infrastructure for soil and water conservation were constructed per watershed which prompted an increase in water retention time by 3 months and reduced soil erosion by 40%.
   - o The water availability in study watershed areas was found to be 82.3 % which is higher than the national average of 73.2%.

ii. **Production system (**Sharma et .al, 2012**)**
   - o The crop intensity increased from 132% to 139% in semi-arid and humid region but no increase in CI in arid region.
   - o Farmers shifted toward commercial crops and horticulture which in turn resulted in increased income.
   - o Increase in the yields of pulses and oilseeds in a semi-arid region while staple crop production tends to be the focus. The increment, in turn, will increase the availability of food for Household consumption.

iii. **Livestock Enterprise (**Sharma et .al, 2012**)**
   - o Surge for alternate livelihood through dairying and other livestock enterprises including poultry. Increase in alternate livelihood through dairying is a result of the increase in fodder, the most expensive component in dairying, because of increase in common pool resources such as forest and vegetation. The report specifically stressed on improving the vegetation in arid and dry semi-arid areas. Small and marginalized farming are attracted towards dairying in semi- arid areas. This is also

contributing to Household milk self-sufficiency and nutrients, increase income.

- Longer water retention periods and constructed water harvesting structure at household and community level provided unique opportunities for inland fisheries. The report found increased inland fisheries production but not in an organized way. Hence the report stressed on treated community Water Harvesting Structures as Common Pool Resources (CPR) and promote fishery in the structure which will benefit small and marginalized farmers.

iv. **Social capital (**Sharma et .al, 2012**)**

- Formation of homogenous groups such as SHGs, UGs, and WCs that consist of landless, women SC and ST helped mainstreaming and empowering the marginalized people, groups, and communities. One watershed committee (WC) has an average of 9 SHGs, 14 UGs, and 6 livelihood Groups. The figure of inclusion of marginalized people is huge if we look at the country level.
- The average number of training sessions per watershed is 9. The study found that an average of 38 people participated in a training. SC and ST constitutes of 45% of trainees and women constitute 42% of trainees. Women and other marginalized groups are prioritized and they actively participate in the training.
- Involvement of community DPR preparation, women in planning and execution works, meetings of WC and Watershed Association (WA) has empowered people at local level.
- The report also found that the sharing of resources and benefits in 2/3 cases were agreed in favor of poor and marginalized people.

v. **Employment Generation (**Sharma et .al, 2012**)**

- Increase in employment by 19 days for men and 13 days for women was found during a one-year period over pre-employment days of 104 and 93 days respectively.
- Non-farm labour days increase from 71 to 87 for men and 59 to 66 for women.
- Reduction in migration by 30 % was found during the study period.

vi. **Economic Effectiveness (**Sharma et .al, 2012**)**

- There are around 5 million SHG in India at Watershed level and their saving is as much as Rs 37, 854 million up to 2007-08.
- Small and marginalized farmers showed an increase in income by 54.6% over their base level income of Rs 38,355 and similar increased was noticed in low and medium farmers group over their pre-projected income of Rs 80,901.
- With the increase in income, there was a reduction in debt which was around 38% in average with small and marginalized farmers.

5 Discussion

The section will discuss the findings from the case study of watershed management

from India on the basis of the theoretical framework described in section 3. The discussion will focus on Watershed Management Projects contribution in increasing resilience in the community and its linkage with the recently adopted 17 SDG goals. The section will further discuss the current issues and challenges in terms of policy and legislation, institutions and role of stakeholders, economic sustainability and community participation in relation to combating the impact of climate and change and achieving the global goals.

5.1 IWM Impact on SDGs

The SDGs were created to provide a holistic, multi-dimensional "road map" to solving the most complex issues on a global scale. SDGs recognize the need for participation of all stakeholders, and the interconnections between all areas of human interactions. Just as the SDGs, Integrated Watershed Management is a multi-faceted, comprehensive approach that demonstrates targeted interventions. Table 2 highlights the direct link of the Impact of IWM to SDG Targets from the Indian Case Study (Sharma et. al, 2012):

Table 2: IWM impact on SDGs

SDG	Impact of IWM (Targets)
SDG 6- Clean Water & Sanitation	6.3 Improve water quality 6.4 Improve water use efficiency 6.5 Implement integrated water resources management 6.6 Protect and restore water-related ecosystems
SDG 2- Zero Hunger	2.1 End hunger and ensure access by all people to safe, nutritious and sufficient food all year round 2.3 Double the agricultural productivity and incomes of small-scale food producers 2.4 Ensure sustainable food production systems and implement resilient agricultural practices
SDG 3- Good Health	3.9 Reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
SDG 13- Climate Action	13.1 Strengthen resilience and adaptive capacity to climate-related hazards 13.2 Integrate climate change measures into national policies, strategies 13.3 Improve human and institutional capacity on climate change mitigation, adaptation, impact reduction
SDG 15- Life on Land	15.1, 15.2, 15.4 Ensure conservation, restoration and sustainable management of all terrestrial ecosystems 15.3 Combat desertification, and restore degraded land and soil 15.5 Take urgent action to reduce degradation of natural habitat, halt the loss of

	biodiversity 15.9 Integrate ecosystem and biodiversity values into national and local planning

5.2 Climate Change Adaptation and IWM

Sharma et al (2012) presented a list of IWM impacts in India on nature conservation, production system, employment generation, the social and economical aspect of communities. The resiliency model of IWM consists of five elements. IWM in India impacted all these elements in one way or another. The impact presented in Sharma et al (2012) report are listed in accordance with elements of resiliencies in table 3. With reference to table 3, IWM directly increases resiliency as it will increase social, physical, financial, natural and human capital at the local level. IWM allows predictability within a watershed scope and allows for stakeholders to engage in a structured process to help create and/or adapt policies and institutions in order to provide sustainable groundwater and continue to improve the livelihoods of those within the watershed. Hence, IWM can be instrumental in ways while adapting with climate change uncertainties.

Table 3: Impact on IWM on Resiliency

Elements of Resiliency	Impact of IWM
Social capital	Watershed management activities such as formation of SHGs, UGs, and WCs, inclusion of landless , SC and ST in committees, training activities for community esp SC, STand landless, participation of community in DPR, equitable access to resources and handing infrastructure to community empowered local people.
Human Capital	Increase in farm and off farm employment, reduction in migration, increased food security and nutrition at the household level.
Financial Capital	Increased saving and credit through SHGs, increased income of small holders and marginalized households.
Physical Capital	Construction of watershed infrastructure such water harvesting and storage structure, increased fuelwood and fodder availability, increased agriculture, livestock production, and productivity.
Natural Capital	Increase in community property resources such as forest and vegetation, increased water availability through water conservation, longer water retention period, and reduced soil erosion.

5.3 Issues and Challenges

Evidence showed that IWM activities in India have increased resiliency in communities against climate change because of its significant contribution to increased water availability, agricultural productivity, vegetation, empowering people through increased employment and production. Also, these impacts are found relevant to SDGs and could contribute to several SDG targets and indicators. However, the following describes the issues and challenges noticed within Indian IWM initiatives.

5.3.1 Scale

Watersheds are hydrological boundaries. The size of watershed varies from 2 hectares to 30,000 hectares. A micro watershed is the smallest unit of a watershed intervention whose area varies from 500 hectares to 1000 hectares. The micro watershed is the internationally accepted scale for intervention design and implementation in a watershed as such a scale helps ensure ecological and institutional sustainability and empowers marginalized and vulnerable populations (Syme et al, 2012). The micro watershed was the scale of intervention in India but they are currently implementing watershed projects at the meso-scale (the watershed with an area of 3000 to 7000 hectares). Working on a micro-scale watershed have limited scalability, do not capture the upstream and downstream benefits and impact, and does not consider river basin level impacts. Implementing watershed projects at the meso-scale would provide some advantages in terms of accommodation of externalities but it will possess similar challenges that were prevalent in micro-scale interventions. The success of a watershed project relies on the impact of the hydrological cycle of the basin with large cooperation between upstream and downstream communities and internalizing externalities (Sym et al, 2012; Reddy et al., 2011). However, all watershed intervention design and impact evaluation in India are based only on on-site local perspective, which completely ignored the impact on adjoining watershed and overall river basin. Though the move towards meso-scale provides some advantages over micro-scale, the focus of Sym et al (2012) on catchment/basin level approaches in designing watershed interventions could provide a strategic way to deal with current and future impacts of climate change.

5.3.2 Watershed Boundary

Watershed is delineated as hydrological boundaries where humans interact with nature and the environment. The Indian government administrative boundaries do not coincide with the watershed boundaries. Water flows across these administrative boundaries which are and will be affected by all administrations, raising conflict among communities and increasing tension as uncertainties increase in the context of climate change. Currently, the management of a watershed in India is a trans-administrative zone management, developing a watershed governance institution in this context is very challenging. Cohen & Davidson (2011) discusses the complexity in boundary choice due to the infinitely nested watershed boundaries which are not congruent with natural system boundaries because of shared ecosystems, airsheds, groundwater flow etc among other factors. Farrington and Lobo (1997) found that the Indo-German Watershed Management Project in India selected watersheds which are aligned with village and district boundaries for project implementation which shows the importance of

alignment of administrative and watershed boundaries.

5.3.3 Convergence and Alignment

The evolution of watershed management has gone through huge transformations since the 1970s. Wani, Rockström & Sahrawat (2011) found that the top – down, and contractual watershed management interventions which were characterized by negligible community participation, inequitable benefits and no transparency in the 1980s have changed in 2008, to a more participatory mode which is transparent, more equitable, and community owned. In 2009, the government of India introduced convergence between MGNREGS – Mahatma Gandhi National Rural Employment Guarantee Scheme, a rural employment program of the government and IWMP; aimed to ensure timely inputs from multiple sources through coordinated planning and services delivery and simultaneously avoiding duplication and redundancies (CAG, 2013). CAG (2013) in their performance study found that in 13 states, there was no convergence at state and district levels. The study further found that the execution of convergence activities was poor and indicated the need for improvement in operational guidelines. In 2015, the government of India introduced new operational guidelines for the convergence of various program and departments within IWMP. The intent was to not only supplement funds for holistic treatment but also complement other development programs (MoRD, 2015). Convergence could be a milestone in watershed management but achieving convergence is very difficult and more often it may create loopholes for increasing corruption. The proper alignment of cross-sectoral departmental institutional structure (process and timelines) at all levels is essential and shall be backed by regular monitoring activities.

5.3.4 Institutional Sustainability

The Indian government institution structure responsible for the implementation of watershed management projects is very bureaucratic and complex. Vania & Taneja (2004) and Reddy et al (2004) found that participation of a community is one of the biggest challenges in watershed projects. Despite a long history of implementation in India, there is a strong complexity of institutionalization resulting from large bureaucracies. Such large bureaucratic institutions are playing an implementing role rather than an enabling one (Vania & Taneja, 2004). Further Vania & Taneja (2004) pointed out the following issues in current institutions and implementations:

- The structure is very inflexible and does not promote innovation at the local level as any innovative activity and must be backed up by a higher level of hierarchy implementation process.
- The resources are highly centralized and the implementation process and utilization of funds are not flexible. This leaves no room for innovation unless backed by a higher level of hierarchy implementation process and utilization of funds.
- The implementation is outcome oriented rather than process i.e. focusing on the use of outside technology.
- Political patronage and interference influence the selection of project areas, recruitment of people and the selection of non-government NGO's for PIAs. NGO's are

formed overnight or affiliated with politicians, in some cases, to allow them to access funds and use them without regulation.

- Retention of human resources has become a critical issue due to the low salary and benefits in comparison with other sectors.

5.3.5 Long run operation

Several researchers have studied the feasibility of the watershed management intervention (infrastructures such as harvesting tanks, dams) and all studies have shown that the watershed infrastructure is financially profitable as the benefit-cost ratio is greater than one (ICRISAT, 2009; Joshi, 2005; and Goel, & Kumar,2009). But these are financial benefits generated from direct and indirect benefits of watershed activities at the household level. It is not guaranteed that people will invest in the operation and maintenance of watershed infrastructure. Reddy et al (2004) studied 37 watersheds in semi-arid regions after the 10 years of completion of a watershed project and found that people are motivated only when there is a direct benefit. Further, the study found no difference in natural resource conservation between watershed implemented and unimplemented communities. Likewise, Singh, Behera, & Singh (2010) found poor maintenance of watershed infrastructure, less/no community participation at the post-project period and lack of institutional mechanisms in the post-project period. Watershed projects and programs, whether implemented by the government or non-government organizations, are temporary in nature and driven by subsidies and other support. Further, there is no long term support provision and institutional structure for watershed management activities at local levels which might have reduced participation in the long run.

6 Lessons Learned and Conclusion

Watersheds are not only a hydrological unit but also a social, environmental, economical and ecological unit wherein complex interaction between human and nature occurs. The watershed management initiatives in India have recognized this dynamic over time as we noticed a remarkable evolution in watershed management from technical, sectoral and fragmented planning to a more holistic and integrated approach since the 1980s. Further, the watershed management has transformed from top-down, and contractual watershed management interventions which were characterized by negligible community participation, and inequitable benefits to a more participatory mode. The current system which is transparent, more equitable and community owned since 2008. Currently, the sector is moving toward convergence at the program and cross-sector department levels. Watershed management convergence can create synergy through input from multiple sources and coordinated planning effort.

Watershed Management project implementation in India has had a positive impact on communities, livelihood and natural resource management. Availability of water, fuelwood, fodder, employment, income, farm and off-farm production, and economic activity has increased within intervention areas. Moreover, local communities, including landless, SC and ST communities were empowered socially and economically. Integrated watershed management

shows enormous potential to contribute to achieving the SDGs as the research demonstrates, IWM can help to achieve more than 5 goals and 13 indicators. Moreover, IWM directly increases social, physical, financial, natural and human capital at the local level which also showed potential to help communities combat with climate change.

In Spite of progressive pathways and benefits at the local level, the research above found that the sector is still struggling on many fronts from policy to implementation at the local level which the list below highlights.

- Consideration of the basin perspective is missing in Policy and planning: Watershed interventions are still designed, implemented and evaluated at the micro and meso level without considering the basin level impact. Administrative boundaries and watershed boundaries are not aligned which we believe could be a source of conflict in the wake of climate change uncertainties.
- Convergence and alignment problem: Though cross-sectoral departments and programs are converged at the central level, they are still segregated at the state to local levels. Convergence in the real sense could be a milestone in watershed management but achieving convergence is a daunting task.
- Orthodox bureaucratic institutional structure: The institutional structure is still highly bureaucratic where resources are centralized and inflexible.
- Sustainability of watershed initiatives is questionable: Reduced or no community participation for operation and maintenance of the watershed infrastructure has raised the question of sustainability in watershed projects. Researchers have argued that people do not participate if they do not see any tangible benefits. Likewise, the lack of long-term monitoring and support provisions and structure has also raised the question of sustainability of integrated watershed initiatives in India.

To further strengthen the participatory approach, encourage decentralized planning, ensure sustainability and strengthen the pathway to convergence in integrated watershed management, it is believed that a more reflexive process is needed. The use of “institutional bricolage” (Merrey & Cook, 2012) highlights rather than trying to impose “new institutional arrangements and water management practices (for example water user associations, water pricing) at local levels, focus rather on facilitating positive processes and innovators (bricoleurs) at local levels”. The desire through this process is to build “adaptive capacity” at the village level while at the macro to focus on creating “effective infrastructure and institutions (through facilitated bricolage)”. The eventual goal being that, as the economy develops, the formal sector will continue to grow and the informal sector will eventually contract. From the analysis, it was found that through the institutional levels within India's IWM there is a large, complicated structural process. In previous years, this structure has caused a diluted focus and turbid understanding of watershed project outcomes from the village to national level. Using an approach that highlights IWM principles imposed from inside-out can be more effective and reshaped through a bricolage process to meet community need. This sort of ‘inside-out’ planning is very important not only in the Indian context but within other similar situations around the world. Such planning approach is of paramount importance in the context of

climate change as the community will be dealing with more uncertainties. Moreover, it would increase long-term institutional and financial sustainability of local watershed infrastructure and institution.

In addition to these, it is noticed that policies should consider the basin level perspective while planning, designing, implementation and evaluation micro or meso watershed level intervention. This will completely change the type of watershed infrastructure, location of installation/construction, and community participation framework as some watershed infrastructure and activities may span across the administrative boundaries. Further, it is believed that aligning the watershed boundaries with administrative boundaries is highly beneficial from a resource management perspective which could avoid trans-watershed conflicts in climate change areas. Yet, many Indian Watershed Policies and programs lack long term provisions to continuously support local watershed initiatives to ensure sustained programming. It is essential to have long term provisions and structures in place to support community watershed infrastructure and institutions.

In conclusion, India's transition to and experience with Integrated Watershed Management from a hydrological to a more inclusive approach demonstrates the potential for continued success to impact not only the watersheds but the lives of individuals who live within them. People's participation is a necessary component and vital throughout the preparatory, watershed works and consolidation phases of IWM. IWM can further increase resiliency and mitigate climate change for members within the basin. Creating an approach that incorporates an institutional structure that is created from the "inside out", employs a basin level perspective, and encompasses financial and institutional sustainability, will ultimately lead to the successful management of a watershed. Just as the SDGs, watershed management has become a multi-disciplinary activity in which appropriate institutional and organizational mechanisms are required for the coordination and implementation of watershed management activities. It is then and only then, that the benefits to implementing an IWM system can be felt by all stakeholders and sustainability can be ensured. The concept of integrated watershed management, just as most water issues, is easily understood, but the implementation of any water strategy including an integrated approach is highly complex.

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Abbreviations

IWM	Integrated Watershed Management
SDG	Sustainable Development Goal
IWRM	Integrated Water Resource Management
DPAP	Drought Prone Areas Programme
IWDP	Integrated Wasteland Development Programme
MoRD	Ministry of Rural Development
DDP	Desert Development Programme
%	Percentage
CLNA	Central Level Nodal Agency
SLNA	State Level Nodal Agency
PIA	Project Implementing Agency
Rs	Indian Rupees
$	United State Dollar
SC	Scheduled Caste
ST	Scheduled Tribe
NRAA	National Rainfed Area Authority
DoLR	Department of Land Resources
VO	Voluntary Organizations
SHG	Self Help Group
UG	User Group
WDT	Watershed Development Team
DWDU	District Watershed Development Unit
DPR	Detail Project Reprot
IWMP	Integrated Watershed Management Project
WDC – PMKSY	Watershed Development Component under Pradhan Mantri Krishi Sinchayee Yojana [Watershed Development Component – Prime Minister Agriculture Irrigation Planning- Translation]
HRD	Human Resource Development
NRM	Natural Resource MAnagement
WHS	Water Harvesting Structure
Sq km	Square kilometer
WC	Watershed Committee