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Dynamics of Water Resources: A Case study of Mehla block of District Chamba (H.P), India

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ABSTRACT

A present study to know the dynamics of water resources and to identify strategic practices to decrease water stress and increase water quality was conducted in Mehla Block of Chamba district of Himachal Pradesh. Each natural water source in these villages was enumerated with the help of enumerators, the Rural Development Department, and panchayats. The present study is based on data collection from Mehla Block of District Chamba. The primary and secondary data collected during the study period were checked, scrutinized, coded, tabulated, analyzed, compiled, and presented systematically by using the simple tabular method. The impact results of field study interventions were analyzed by working out with the help of simple average and percent methods. The study has shown that there are a number of traditional water sources, irrigation sources, and lifts (Electric) in the study area. In Mehla Block irrigation works were supplying water to households for domestic and irrigation purposes with no dug wells, tube wells, or canals being used for irrigation. Among groundwater sources, the Block does not have any sources. However a total of 2 electric water extraction devices are available through the Block. Kuhl system is the major irrigation system in the block, and water users associations exist at various places. The present water demand has been assessed to be 17.51 MCM annually. Out of the total water demand is 74% is the requirement for crop production. Nearly 13% is required for domestic drinking water and 13% is required for livestock water requirement purpose. The present study revealed that out of the total water budget in Mehla Block is 16% surface water and 0% ground water availability were present. The Mehla Block had 10.6 million cubic meter water budget of water. The water budget shows moderate gaps (6.9MCM) between water availability and water demand in the block. If the existing water availability is continued the water gap is likely to increase further in future (11.1MCM) and as a result the unmet demand for water is likely to go up reaching. Sustainable development is a dynamic process which is underpinned by social-ecological sub-system. Rooted in systems thinking, the system dynamics approach was adopted in this study to assess the water resources development path in Mehla Block of Chamba District. It was shown that it is not sufficient just to balance water supply and demand; but, it is essential to take care of dynamics which will in long-term cause consequences threatening water supply-demand balance. To meet the water demand the traditional water systems must be preserved, periodic monitoring of water quality should be done as well as rain water harvesting practices must be adopted.

Introduction

Water is a transparent, tasteless, odorless, and nearly colorless chemical substance, which is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. It is vital for all known forms of life, even though it provides no calories or organic nutrients. Water plays an important role in the world economy large quantities of water; ice and steam are used for cooling and heating, in industry and homes. Water is an excellent solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, and diving. Essential, Reliable and Invaluable water is the thread that weaves together our daily lives. It keeps our communities healthy, our cities running, and our economies growing. People value water and water environments for a diverse range of reasons. Water is essential for human life and wellbeing, is critical to food production, and is a part of many manufacturing and industrial processes. Indian have a deep connection with the water environment of rivers, lakes, estuaries, and coasts, which are central to much recreation and tourism, and for indigenous people water environments have a deep spiritual meaning (Rosalind Bark.*et,al.,* 2011)

This is studied that Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. At present more than one billion people on earth already lack access to fresh drinking water. By the year 2025 the demand for freshwater is expected to rise to 56% above what currently available water can deliver, if current trends persist. The available water resources in many parts of the country are getting depleted and the water quality has deteriorated. It has been predicted that by 2050 India is going to be water scarce due to the continuous and increasing demand for water (Anitha Sampath.*et,al*., 2003).

According to Samar Lahiry, 2017, India has only about 4 per cent of the world's renewable water resources but is home to nearly 18 per cent of the World's population. It receives an average annual precipitation of 4,000 billion cubic meters (BCM) which is the principle source of fresh water in the country. However, there is wide variation in precipitation across different regions of the country. India has about 20 river basins.

Due to increasing demand, most river basins are water stressed. This is further accentuated by the fact that water demand is unevenly distributed across the country. Increasing demand from a growing population, coupled with economic activity, adds pressure on already stressed water resources. Per capita annual water availability reduced from 1816 cubic meter in 2001 to 1544 cubic meter in 2011. With the country already experiencing water stress, there is need to augment both water supply in water-rich regions lacking infrastructure and manage water demand in water-scarce regions. There is enormous pressure on planners to provide utility services, and water supply is a priority, especially where peri-urban water is exported formally or informally to fulfill city requirement.

At the same time, the urban return flow (wastewater) also increases, which is usually about 70-80% of the water supply. According to recent projections, India's urban population of 380 million (2008) is expected to increase to 590 million by 2030, twice the current population of USA (MGI, 2010), with regional cities expanding at a faster rate than the larger cities. Already, many cities can be now considered as 'sponges' absorbing water from peri-urban and rural areas through formal and informal channels. A large number of these growing cities are located in major river basin catchment with poor-quality water and pollutants above the permissible levels being released into the environment (MoEF, 2009) and thus polluting irrigation water as well as posing major challenges for urban wastewater management (Priyanie Amerasinghe.*et.al.,* 2013)

Groundwater plays an important part in India's economy. It caters to about 85% of rural demand, 50% urban requirements and more than 60% of our irrigation needs. Unregulated groundwater extraction has led to overuse in many parts of the country, causing the groundwater table to plummet, drying springs and aquifers' **Samar Lahiry, 2017).** Ground water extraction through springs and hand pumps are the major sources of water supply, but the availability of water during summer is limited particularly in lean periods and requires immediate attention to augment the ground water resources. Based upon the climatic conditions, topography, hydrogeology of the area, suitable structure for rain water harvesting and artificial recharge to ground water are required. Proper scientific intervention for spring development and revival is required in water scarce areas. In the hilly areas, roof top rainwater harvesting structures like storage tanks are recommended while in low hill range, check dam and roof top rainwater/snow harvesting structures can be adopted.

Water Budget can be defined as the relationship between the inflow and outflow of water through a specified region. It gives a comparison between the supply and demand of water, making it possible to identify periods of excess and deficit precipitation. The balance between the available water in the country and the water under use. The annual water availability in terms of utilizable water resources in India is 1,122 km^3.Besides this, the quantity of 123 km^3 to 169 km^3additional return flow will also be available from increased use from irrigation, domestic and industrial purposes by the year 2050. The per capita availability of utilizable water, which was about 3,000m^3 in the year 1951, has been reduced to 1,100m^3 in 1998 and is expected to be 687m^3 by the year 2050.(Jain at al, 2007)

The water problem is not only confined to the quantity of water available, but also to the quality of water available. In many resources, the water has excess iron, odor and fluoride and infected with guinea worms. A regular water quality monitoring is particularly important for bacteriological contamination. To facilitate this work, initially, district level water quality testing laboratories have to be set up. The ultimate aim is to provide safe drinking water and generate awareness about water quality among rural masses. A study on water cannot be devoid of its hydrological system defined as a balance between and evaporation. This system is controlled by many factors like evaporation, transpiration, infiltration, interception, run-off and overland flow, soil moisture storage, groundwater storage, and recharge. This hydro-dynamics is further interfered by the human and animal population by making extraction demands. Extractions are guided partly by basic need considerations and partly by development (which includes abatement of pollution or the management of externality). All extraction factors again depend upon the intensity of rain and snow fall, temperature, slope condition, vegetational cover, soils, geological and topographic cover and land use patterns.

The Chamba district is full of perennial springs they differ considerably in their discharges. By and large these springs are used for domestic, livestock and irrigation purpose. For domestic purpose water has been drawn at source where ready arrangement exist for filling containers or elsewhere water channels have been dug to carry water from springhead to the village concerned. With the progress of development, pipelines are increasingly laid down, thus improving the convenience and efficient water supply. The drinking water supply for Chamba town is met with mainly from two nallahs viz., Sarotha and Sal nallah. It is such a complexity of water dynamics of the Mehla Block which is attempted to quantify in this paper. Such a hydrological analysis covering both the supply and demand factors is extremely relevant for planning a sustainable development for a Mehla Block. Therefore, a detailed and accurate water resources inventory is deemed necessary to ensure that proper management is executed to promote better sustainability. And to identify strategic practices to decrease water stress and increase water quality.

Materials and methods

Study area

Mehla Block is drive from name from Mehla village in Chamba District of Himachal Pradesh, India. It is located at 11km towards South from District headquarters Chamba. Mehla is surrounded by Chamba Tehsil towards North, Bhattiyat Tehsil towards west, Saluni Tehsil towards North, Dharamshala Tehsil towards South. The elevation is 489 meters above sea level. Total geographical area of Mehla village is only is 139.77 hectares and Mehla block is comprises of 42 Panchayats with an area of 887.98 km^2 in the district.(Fig :1)

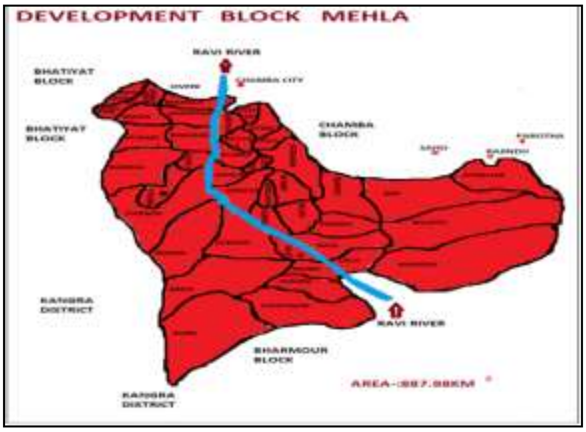

Fig: 1 Map of Study Area (Mehla Block)

Sampling Methodology

Each natural water sources in these villages was enumerated with the help of enumerators, Rural Development Department and panchayats. The present study is based on data collection from Mehla Block of District Chamba. For the selection of natural water sources a primary survey was connected of Mehla Block of Chamba District. Both primary and secondary data matrixes have been used in the preparation of this case study. While published and unpublished sources are taken in account for secondary data, the primary data was generated based on spot verification, field observation, questionnaires and case studies. A preliminary field visit was made to get an idea of the water sources in the study area. The primary data were collected on the basis of a survey schedule. The data were collected through personal observation method from the block in study area. The secondary data used in the study was collected from irrigation and Public Health Department, Rural Development Department, Panchayats and Agriculture Department.

Sampling Population

As per Census 2011 Mehla Population is 96809(43,009 Males, 41209 Female and 12591 Children), Literacy ratio in this block is 58%. In Mehla Block the total number of members of Schedule Caste is 16229 i.e. 19%, the total number of members of Schedule Tribe is 20497 i.e. 24% and the number of Members of General Category is 47492 i.e. 57%.

Data Analysis

The primary and secondary data collected during the study period was checked, scrutinized, coded, tabulated, analyzed, compiled and presented systematically by using simple tabular method. The results have been presented by working out simple averages and percentages and are discussed. The production, productivities, input use, costs and returns etc. associated with different crop enterprises were estimated before and after the project intervention. The impact of project interventions was analyzed by working out per cent. Water Demand was calculation by like that say one person consumes=X liters per day (i.e., “X” lpcd(liters per capita per day) Total number of population in a community =“P” Total daily water demand = (X) *(P) liters per day Say amount of water required for duration = “T” days, Total amount of water required (V total)= (X)*(P)*(T) liters • The water source should have this much (i.e.,V total) to be considered as a potential water source.

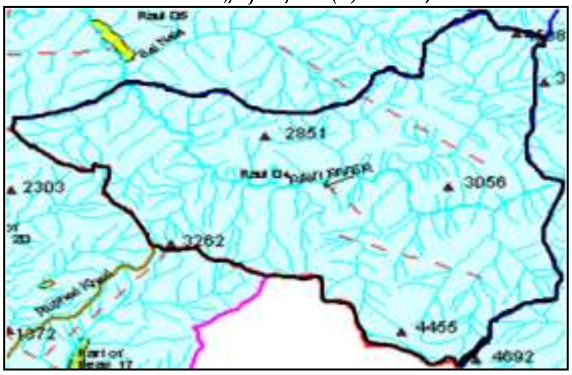

Fig: 2. Physiographic and Drainage Map of Mehla Block

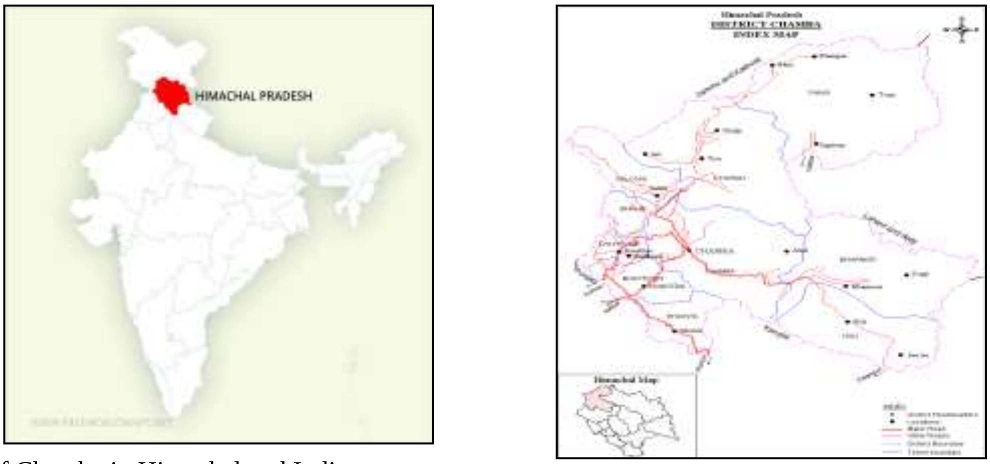

Fig 3: Map of Chamba in Himachal and India

Result & Discussion

Water is one of the most vital natural resources of Himachal Pradesh. The state is richly endowed with a hilly terrain having an enormous volume of water from the catchment areas of Satluj, Beas, Ravi and Chenab rivers. As such, the state has enormous potential of water resources in the form of glaciers and rivers but ground water resources are limited. The major consumptive use of water in the State has been for irrigation. The gross irrigation potential of the state is estimated to be 3.35 lakh hectare, while the irrigation potential created has reached 2.56 lakh hectare by September 2013.

The area of the district is 6,522 sq.km with Chamba as its Headquarters. There are 1591 villages in the district. The district has been divided into 6 Sub divisions (Chamba, Churah, Salooni, Pangi, Bharmour, Dalhousie, Bhatiyat) & 3 sub-tehsils (Bhallai, Holi, Sihunta). Further, for development purposes the district has been sub-divided in 7 CD blocks viz., Chamba, Mehla, Bharmour, Tissa, Salooni, Pangi, Bhatiyat.

Mehla is a Block located in Chamba district in Himachal Pradesh. Situated in rural part of Himachal Pradesh, it is one of the 7 blocks of Chamba district. As per the administration register, the block code of Mehla is 6. The block has 185 villages and there are total 14,035 homes in this Block. The Block has 42 panchayats.

As per 2011 census, the total population of the Mehla Block is 96,809 persons (43,009 males, 41209 females&12591 children) i.e., 44% males, 43% females and 13% children. It was also found that the male population is higher than the female one. In Mehla Block, the total number of members of Schedule Caste is 16,229 i.e.,19%, the total number of members of Schedule Tribe is 20,497i.e.,24% and the number of members of General Category is 47,492 i.e.,57%. Mehla Block has the highest number of General category population (As per report of Development Block Mehla, District). Literacy ratio in Mehla Block is 58%. Among males the literacy ratio is 67% whereas female literacy rate is 49%.

Block has an area of 94,324 hectares but because of the physiographic constraints the area for land use is restricted and hence the cultivated or gross cropped area is 7,207 i.e., 7%The net sown area of the Mehla block is 6,976 i.e., 7% and the cropping intensity is 135%.The major proportion of the area falls under Forest is 58,725 i.e., 55%. The major proportion of the area under Watershed is 2,755 i.e., 3% and the area under Pasture is 25063 i.e., 23%. Mehla Block comprises of four major soil classes namely Clay, Sandy, Loam and Sandy loam soil The block spread (area in hectares) of the major soil classes is depicted in figure below-

Detail of Water Availability & Domestic Water Demand -The sources of water availability in Mehla Block is Lift Irrigation/Diversion or Perennial /spring source of water. The total Lift Irrigation of water is 6.382 in which for Kharif crops is 2.159 i.e.(34%),Rabi crops is 3.123 i.e.,(49%)and for Summer crops is 1.1 i.e.,(17%) whereas the total water availability of Perennial/spring source is 4.26 in which for Kharif crops is 1.4 i.e.,(33%),Rabi crops is 2.1 i.e.,(49%) and for Summer is 0.76 i.e.,(18%).The Gross Water Demand for 2015(million cubic meters) was 2.29 whereas 2020 (MCM) is 2.43. (Table 1, Fig .4) (As per District Irrigation Plan, 2015-2020 Chamba, H.P. state)

Table.: 1 Water availability of Mehla Block.

Sources	Kharif	Rabi	Summer	Total
Lift Irrigation/Diversion	2.159	3.123	1.1	6.382
Perennial/spring source of water	1.4	2.1	0.76	4.26
Total	3.559	5.223	1.86	10.642

(As per report of District Irrigation Plan, 2015-2020 Chamba, HP)

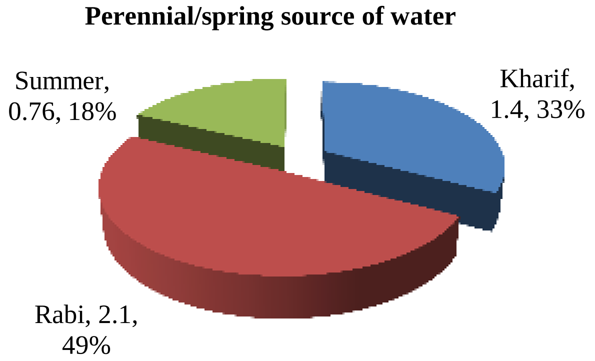

Fig 4 Pie chart showing the perennial source of water.

Total Water Demand for various sectors: The total water demand for Domestic purposes is 2.4 MCM i.e 11% where for crop and Livestock the demand is 60% and 29% respectively. The total number of irrigation Sources is 24 i.e., 48% and the other sources including traditional are 24 and the water extraction devices (Electric) are only 2. (Fig.7)

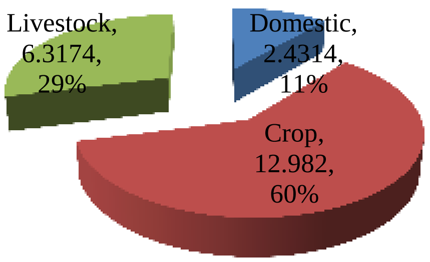

Fig: 5 Pie chart showing the total water demand of the Mehla Block.

Present Water Demand & water budget **-**The present water demand of the block has been assessed to be 17.51 MCM annually. Out of the total water demand 12.982 MCM i.e., 74% is the requirement from crop production. Nearly 2.3 MCM i.e., 13% is required for domestic drinking water requirement and another 2.2MCM i.e., 13% is required for livestock water requirement purpose (Fig. 6).

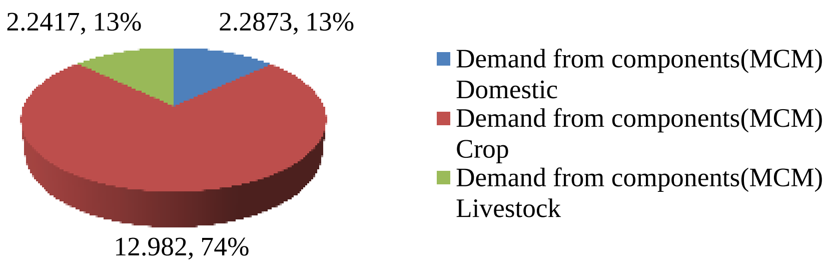

Fig: 6 Pie chart showing the Present Water Demand of Mehla Block.

Most importantly water budget shows moderate gaps between water availability and water demand in the block. While the availability at present is 10.6 MCM i.e. 16%, the present water demand is 17.5 i.e., 26% giving rise to an unmet demand of close to 6.9. If the existing water availability is continued the water gap is likely to increase further in future and as a result the unmet demand for water is likely to go up reaching 11.1 MCM (16%). The water budget analysis suggest that urgent efforts are required to meet the water requirements of the block as the gap is likely to increase in future. Utilizing the surface & ground water potential in the block, activities that promote ground water help in recharge, soil moisture and water conservation etc. (Fig 7)

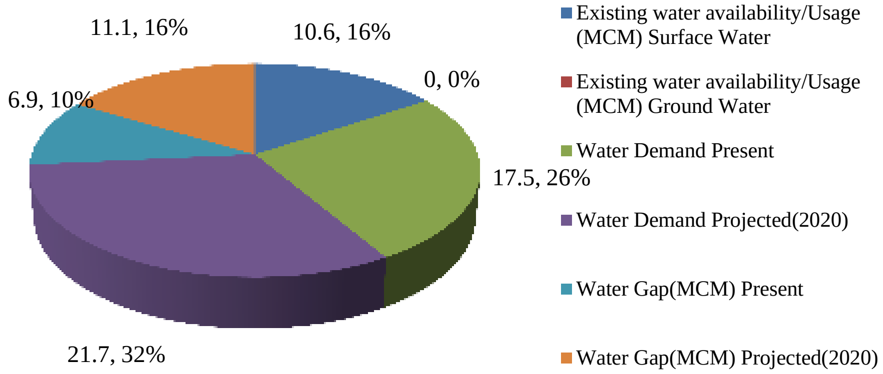

Fig: 7 Pie chart showing the water budget of Mehla Block.

The gross irrigated area of Mehla Block is 875 hectare i.e., 61% where the Net irrigated area is 462 hectare i.e., 33% where the totally rainfed area is 6655 Ha.

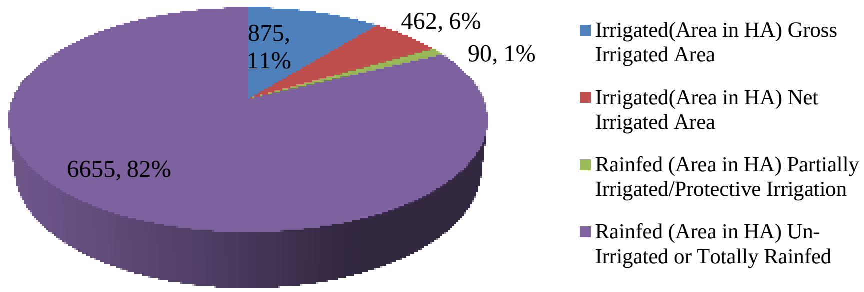

Fig: 8 Pie chart showing the Irrigation based classification.

In 2016-2017 the Mehla Block Budgetary outlay under Watershed Component was 1189.4 Ha. Whereas in 2019-2020 the Budgetary outlay under Watershed Component is 945.4.(Fig.8)

Discussion

The present water demand of the Mehla block of Chamba district has been assessed to be 17.51 MCM (million cubic meters) annually. Out of the total water demand is 74% is the requirement for crop production. Nearly 13% is required for domestic drinking water and another 13% is required for livestock water requirement purpose. To meet out with the above water demand in Mehla Block there are well planned irrigation schemes are running in Mehla Blocks. The total number of irrigation sources is 24 i.e., 48% and the other sources including traditional is also 24 i.e., 48% and the water extraction devices (Electric) is only 2 i.e., 4%. Another study has been done by Shivendra Kumar Srivastava *et.al., (2013)* on Irrigation Development and its Impact on Agricultural Productivity in India wherease Nikhat Bano(2013)studied on the Sources of Irrigation and Agriculture Development in India. Amarjit Singh Sethi (2011) studied the Gravity Flow Irrigation System (Kuhl) in Himachal Pradesh and Inderjeet Singh *et.al.*, (2013) studied Irrigation System in Indian Punjab.

The present study revealed that out of the total water budget in Mehla Block of Chamba district is 16% surface water and 0% ground water availability were present. On an average Mehla Block had 10.6 million cubic meter water budget of water as per official District Irrigation Plan, 2015-2020 Chamba, Himachal Pradesh. Same study has been done by the different researchers. In India like Tarun Umakant Sharma (2013) studied the Water Budget Components Estimation using Satellite Data and a Hydrological Model in Madras whereas In China, Wenbin Liu *et.al.*,(2017)Investigate water budget dynamics in 18 river basin across the Tibetan Plateau through multiple datasets and Edrick Ramos(2016) studied the Small scale water budget approach and water quality assessment in Calderas Lake Guatemala. Another study has also been conducted Water Budget Analysis and Groundwater inverse modeling in Iran by the Sayena Farid Marandi (2012) because, the water budget shows moderate gaps between water availability and water demand in the block. If the existing water availability is continued the water gap is likely to increase further in future and as a result the unmet demand for water is likely to go up reaching. A total number of 139 hand pumps has been installed in the block. There are total 392 Water supply scheme sources in the block and there also have a 1,259 delivery point and 11 Public & Private sources. According to the people many perennial sources had changed to seasonal water sources, many sources that were earlier used to fetch water for drinking were used for domestic and irrigation purposes only and some sources were not used at all. Occurrence of available and exploited water resources and variation in use, may be attributed to topography, slope, terrain, rainfall, total area of panchayat, land use, water resource management, aquifer systems, surface and ground water systems, population, extend of various construction, development activities.

Conclusion

The main findings of the study are as under; the study has shown that there are number of traditional water sources, irrigation sources and lifted (Electric) in the study area. In Mehla Block irrigation works were supplying water to households for domestic and irrigation purposes with no dug wells, tube wells or canal being used for irrigation. Among ground water sources, the Block does not have any sources. However a total of 2 electric water extraction devices are available through the Block. Kuhl system is the major irrigation system in the block, and water users associations exist at various places. Several system dynamics models have been developed for water resources management which provides a synthesis of system dynamics tools for water management. The present water demand has been assessed to be 17.51 MCM annually. Out of the total water demand is 74% is the requirement for crop production. Nearly 13% is required for domestic drinking water and 13% is required for livestock water requirement purpose. The present study revealed that out of the total water budget in Mehla Block is 16% surface water and 0% ground water availability were present. The Mehla Block had 10.6 million cubic meter water budget of water.

The water budget shows moderate gaps (6.9MCM) between water availability and water demand in the block. If the existing water availability is continued the water gap is likely to increase further in future (11.1MCM) and as a result the unmet demand for water is likely to go up reaching. Sustainable development is a dynamic process which is underpinned by social-ecological sub-system. Rooted in systems thinking, the system dynamics approach was adopted in this study to assess the water resources development path in Mehla Block of Chamba District. It was shown that it is not sufficient just to balance water supply and demand; but, it is essential to take care of dynamics which will in long-term cause consequences threatening water supply-demand balance.

For sustainable development of natural water sources the following measures are suggested-To meet the water demand of increasing population, urbanization and industrialization the traditional water systems must be reexamined, reinvestigated and preserved. These sources must be cleaned regularly and disinfected periodically and be kept free from contamination. Where there are chances of contamination in traditional water sources these must be covered with roof and protected with netted doors. Periodic monitoring of water quality must be ensured to check the deterioration in their quality. People participation and environmental education are pivotal and needs to be encouraged. Persons involved polluting/destroying the water sources must be severely penalized and sentenced to rigorous imprisonment for six months. Since not much research has been done on Dynamics of water resources of the Himachal Himalayas, the study is a beginning in this direction and not an end. Much more research is yet required to be done. Multidisciplinary research on traditional water sources of the entire state is required. Deeper and wider applications of the social, economic and managerial aspects the system is necessary. A wide body of realistic data of all ground water sources needs to be collected. The water quality of all the water sources must be monitored regularly and database needs to be developed. Water is major force in socio-economic growth of the region. If the development of water sources has to be sustainable, equitable and community based traditional systems have to be rejuvenated, developed and preserved.

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