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RESEARCH ARTICLE

COMPREHENSIVE ASSESSMENT OF WATER DEMAND, SUPPLY DEFICIT, AND SUSTAINABLE MITIGATION STRATEGIES: A CASE STUDY OF CHOULDARI GRAM PANCHAYAT, SOUTH ANDAMAN

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Abstract

Water scarcity poses a critical challenge to rural communities in island ecosystems, where geographical isolation and seasonal hydrological variability constrain resource availability. This study presents an empirical analysis of water supply, demand dynamics, agricultural consumption, and future forecasting for Chouldari Gram Panchayat in the South Andaman District of Andaman and Nicobar Islands, India. Drawing upon census data, hydrological assessments, and Geographic Information System (GIS) spatial mapping, this paper evaluates the current 61% potable water deficit and models future requirements up to the year 2050. A survey was carried out by Island Water Resource Research Center (IWRRC), a center established by Dr.B.R.Ambedkar Institute of Technology in the Panchayat. To bridge this demand-supply gap, a multi-phased mitigation framework is proposed, incorporating source augmentation, watershed development, and household-level grey water treatment using upflow-downflow filtration systems.

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Introduction:-

Chouldari is a Gram Panchayat in South Andaman District of Andaman and Nicobar Islands, India. It is located in Ferrargunj Tehsil of South Andaman District and covers a geographical area of 1054.34 hectares. It is situated 17km away from sub-district headquarter Ferrargunj and 22km away from district headquarter Port Blair now known as Sri Vijay Puram. The Chouldari Gram Panchayat (GP) comprises of four villages namely Chouldari, Craikabad, BadmashPahar and Port Mort. The four villages are further divided into twelve wards. Administratively, the Chouldari Gram Panchayat consists of four constituent villages divided into twelve administrative wards:Chouldari, Craikabad, Port Mort, BadmashPahar (also recorded as Badmaspahad)The Panchayat has a population of 4323 as per the latest census carried out by Pancahayati Raj Institutions (PRI). District of South Andaman is one of the three Districts of Andaman & Nicobar Islands is located in between longitude E 92° to E 94°' and latitude N 6°' to N 14°' in the Bay of Bengal Region. Languages spoken in the Panchayat include Hindi, Bengali and Tamil and the villagers are mostly occupied with Agriculture , Government Service, Agro based business.

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Hydrological Assessment & Water Resources:-

Socio-hydrological surveys reveal that a majority of farming households possess private water extraction infrastructure, predominantly comprising dug wells, farm ponds, and direct tapping of seasonal/perennial streams. However, escalating domestic and agricultural demands driven by economic growth, dietary changes, and land-use shifts have strained private reserves. Consequently, the population relies on the centralized potable water distribution network operated and maintained by the Andaman Public Works Department (APWD). The survey revealed various types of water sources in different areas of the entire Panchayat which as shown in Figure 1.1.

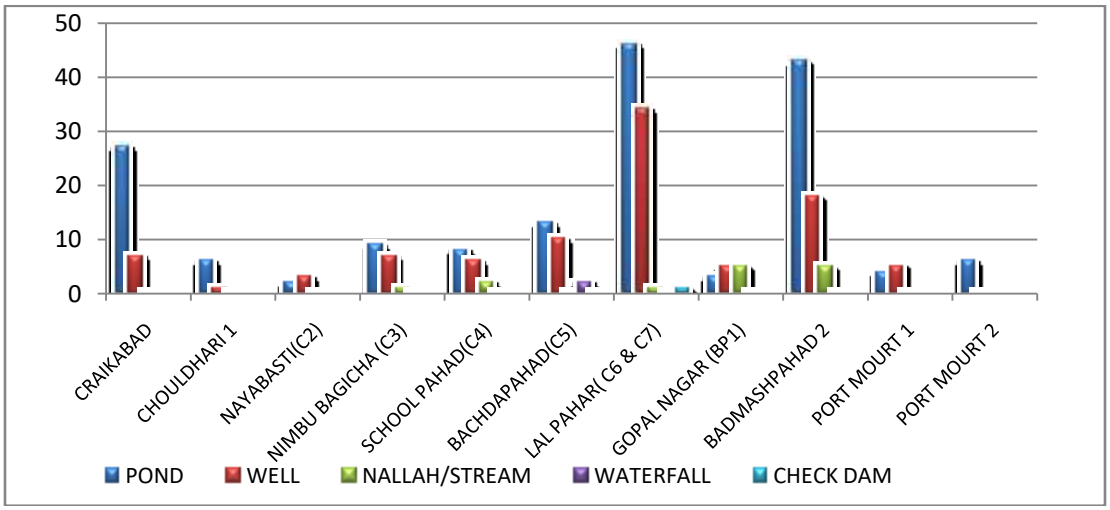


Fig 1.1 – Types of water resources in Chouldhari Gram Panchayat

GIS Spatial Mapping & Ground Conditions:-

The GIS mapping of available water sources was carried out to locate and assess the water availability in the Gram Panchayat. The qualitative and quantitative analyses of these individual sources are to be carried out for both monsoon and dry season. Moreover, none of these sources are connected to the drinking water supply system since they are owned by individual households. The GIS maps were prepared with different layers to appraise availability of water sources in the spread of population. These individual sources owned by villagers were having perceptible amount of water during the survey carried out in the dry season of May-June. Thus, indicating the occurrence of appreciable amount of ground water in these areas. The GIS mapping for the entire Chouldhari Gram Panchayat (GP) is shown in Figure 1.2 and Figure 1.3 where as different layers of GIS map showing various types of water sources is separately shown in Figure 1.4 to 1.5 respectively



Fig 1.2 –GIS Map showing location of different villages in Chouldhari GP



Fig 1.3 –GIS (Layer) Map showing location of streams in Chouldhari GP

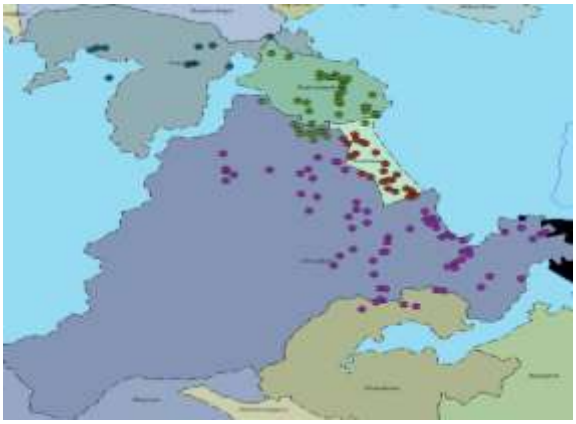


Fig 1.4 –GIS (Layer)Map showing location of Ponds in Chouldhari GP



Fig 1.5 –GIS (Layer) Map showing location of Wells in Chouldhari GP

Water Requirement Analysis: Current Deficit & Future Projections:-

The central source of municipal intake is from the Chouldari Earthen Dam, from which raw water is conveyed to a treatment plant prior to scheduled distribution by the APWD. Water is supplied once every 3 days (500,000 liters per batch), which previously dropped to once every 5 days during peak summer periods. Further, as per IS 1172-1993 the requirement, with daily consumption assessed as 100 liters per capita per day (LPCPD), for the present population is 4.3 lakhs litre per day. Whereas, the present supply to the village is only 1.66 lakhs litre per day. This quantitysuffices only 38 LPCPD capita per day. Thus, there is a shortage of 265633 liters/day outlining a gap of 61%. The present supply-gap comparison is shown in Figure 1.6

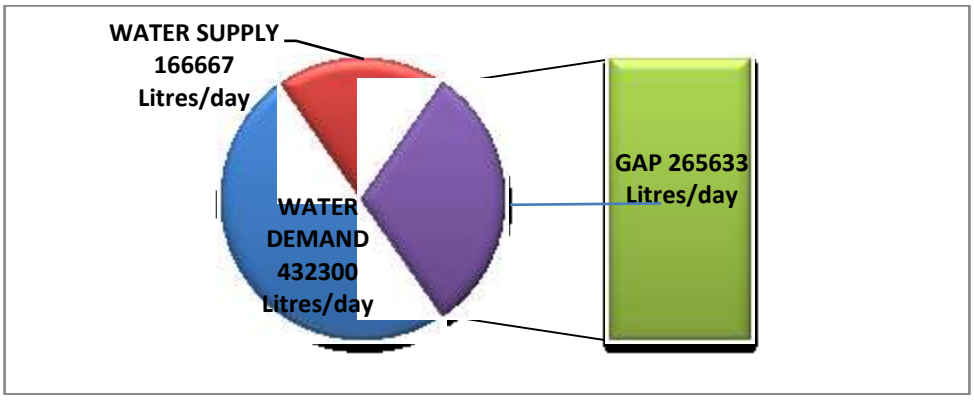


Fig 1.6 –Comparison of Existing Water Supply, Demand & Gap in Chouldhari GP

Population Growth Trends & Long-Term Forecasting:-

There is a marginal increaseof populationi.e22 % from 2001 to 2011 whereas the increase in population during 2011-20 is only 15%. The demography and change in land use pattern is also responsible in population growth rate. The migratory population is not considered in the assessment therefore the water demand is estimate is for the entire population registered with Panchayat.The incremental growth of population in four main villages of Chouldhari and for Gram Panchayat for last three decades is shown in Figure 1.7 and 1.8

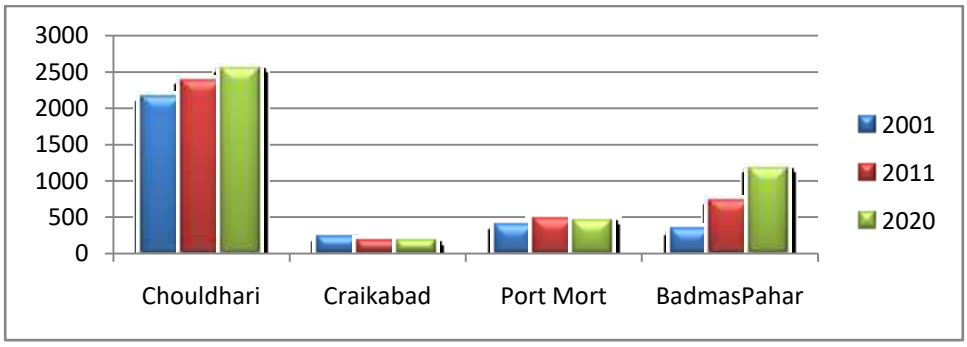


Fig 1.7 –Growth of population in villages of Chouldhari GP

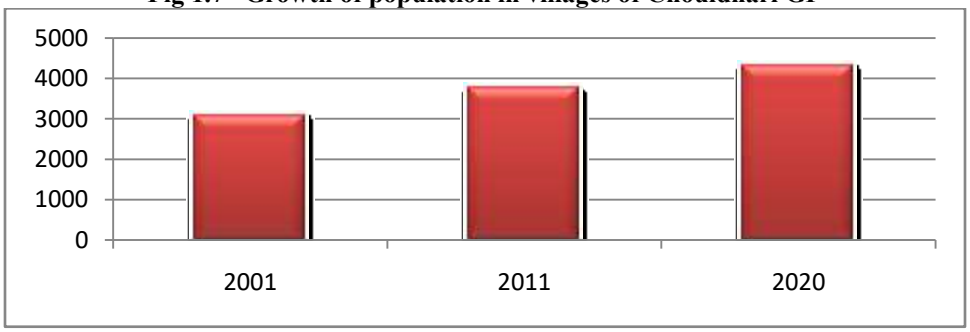


Fig 1.8 –Growth of population in Chouldhari Gram Panchayat for three decades

Further, population forecasting was carried out with commonly applied three methods which indicate a maximum increase of 12%-18 % till 2050. The demand and supply analysis was carried out with population forecasting.The graphical representation of decadal population growth is shown in Figure 1.9

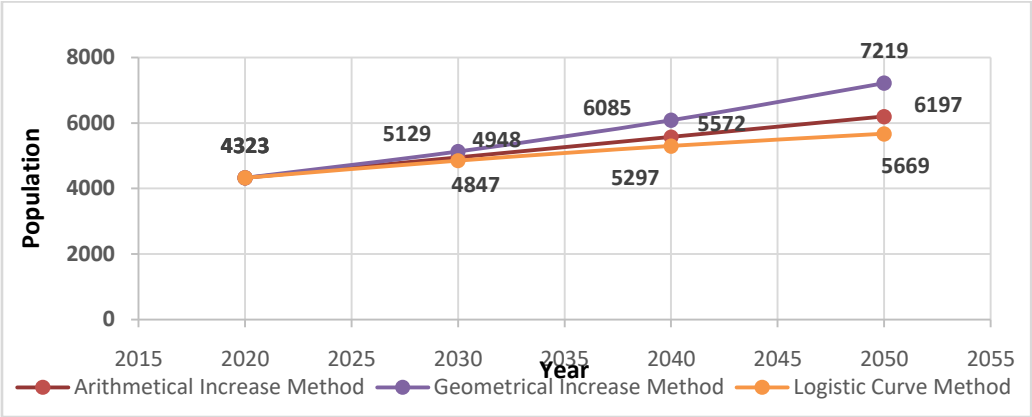


Fig 1.9 –Population Forecast for Chouldhari Gram Panchayat

Agricultural Water Demand Dynamics:-

The rolling terrain of Chouldhari GP is utilized for farming both for seasonal and cash crops by the villagers. As per the information obtained from Agriculture Department the distribution of land used for Paddy (Rice crop) growing and remaining hilly area (in hectares) is shown in Figure 1.10. Further, the villagers also grow seasonal vegetable in addition to the cash crops and plantations which include spices, coconut, Arecanut etc. The water requirement for paddy crop is met by the annual/seasonal rain.The Delta i.e. total depth of water required to raise the crop for paddy, as per Indian Council of Agricultural Research (ICAR), varies from 900 mm to 1300mm for high water table area to high land area respectively. Therefore, the monsoon dependent crop is not very popular in the village due to non-consistent rainfall in last few years. Therefore, villagers have adopted cash crops like season vegetables for which water requirement varies from 400 to 600 mm per season. Considering the non-paddy growing lands to be utilized for cash crops the water requirement for the existing agricultural practices is shown in Figure 1.11.

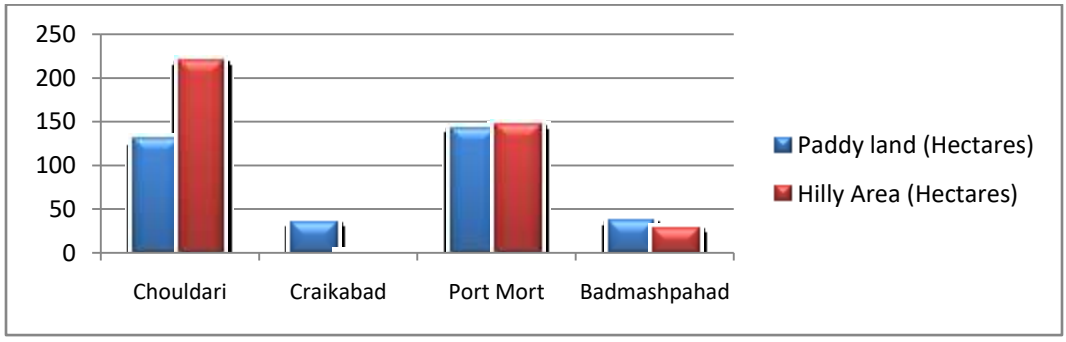


Fig 1.10 – Distribution of Paddy and Hilly land in Chouldhari GP

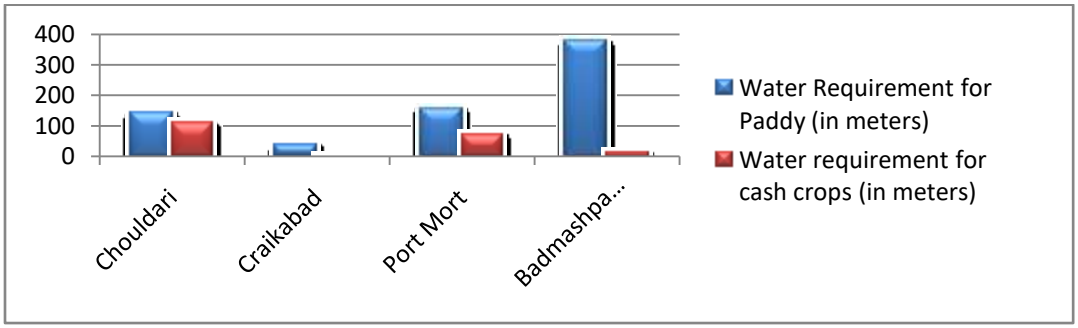


Fig 1.11 – Water requirement for existing agricultural practices in Chouldhari GP

Thus, Kharif crops are dependent on rain and the other cash crops are dependent on well/pond irrigation. Further the Net irrigation requirement (NIR) also includes leaching, pre-sowing and nursery water requirement during the entire crop season. Therefore, the sustainability of agricultural practices will depends on various rain water conserving practices to charge the ground water to sustain water availability in the area.Proposedmitigation framework &gap elimination after conduct of Hydrogeological field surveys have been identified with three local sources having perennial dry-season discharge and suitable for immediate infrastructure development. They identified sources includes ; 1.Proposed Large-Diameter Dug Well Site**:** Located near the existing Chouldari Earthen Dam catchment, 2.Perennial Stream Source **:** Located within the Panchayat watershed boundary and 3.Perennial Stream Source 2**:** Located in the adjacent runoff basin.These sources are indicated in Figure 1.12



Fig 1.12–Potential Water Sources for Immediate Argumentation

Supply Expansion & Deficit Impact Modeling:-

The three proposed sources are expected to append approximately 3 Lakh liters per day to the present supply which include 1 Lakh litres from the Dug well and 0.5 Lakh liters each from stream 1 and Stream 2 respectively. These discharges are assessed on the basis of their present yield which required to be validated for dry months. Therefore, looking into the marginal increase in the population these sources will increase per capita water supply to 84 LPCPD from the existing 38 LPCPD. The comparison of existing water demand vs supply and the per capita increase in supply is shown in Figure 1.13. . The substantial reduction in gap between water requirement vs demand for future decades is shown in figure 1.14 respectively.

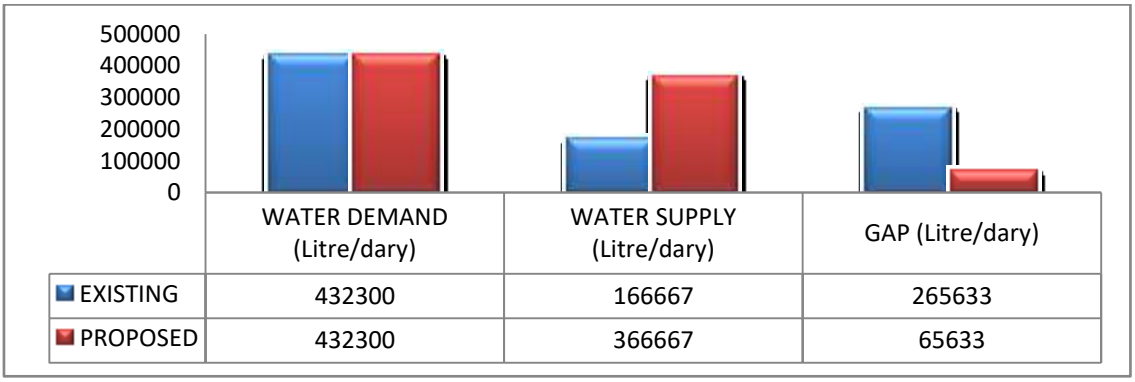


Fig 1.13–Comparison of existing and proposed water supply with additional sources

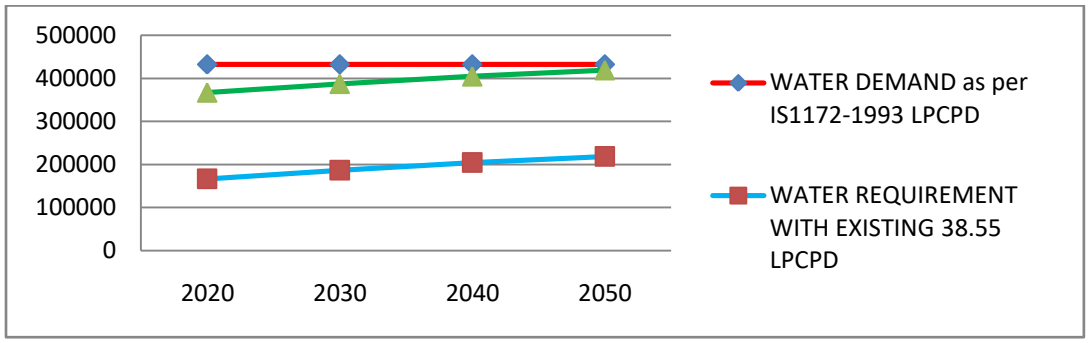


Fig 1.14–Gap Mitigation with augmentation of sources for future requirement

Watershed Development & Groundwater Recharge Structures:-

The gram Panchayat is having a rolling terrain with hilly side mostly covered with forest. Hence, the seasonal crops are grown in plain lands whereas cash crops are spread across other terrain of land. The watershed management plan for land and moisture conservation, ground water recharge, development of productive afforestation, agriculture production, grasslands and horticulture can be included to conserve irrigation water. The contour map showing the terrain pattern for Chouldhari Gram Panchayat is shown in Figure 1.15

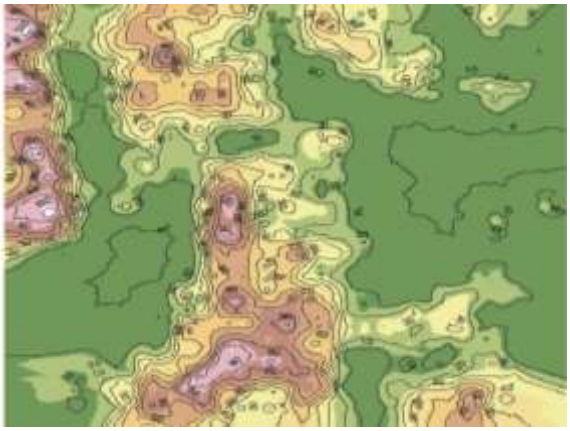


Fig 1.15–Contour Map for Chouldhari Panchayat (Source-Google Map)

To retain surface runoff and enhance aquifer percolation in Chouldari's rolling terrain, structural soil and moisture conservation interventions recommended by the CPR Environmental Education Centre (CPREEC) include:-

- Contour bunding / graded bunding
- Check dams and gully control structures
- Land levelling / land smoothening
- Bench terracing
- Farm ponds
- Percolation ponds
- Waterways
- Diversion drains

Decentralized Household Greywater Recycling:-

In the absence of conventional groundwater and perennial sources the most exceptional option and cost efficient source in rural area would be the treated grey water utilisation for irrigation purpose. As per the existing data there are 1043 households in Chouldhari gram Panchayat. The National Environmental Engineering Research Institute (NEERI) Nagpur, had quantified the grey water produced in rural areas and with the demographic and social conditions of Chouldhari Panchayat the grey water production in existing scenario is shown in figure 1.16

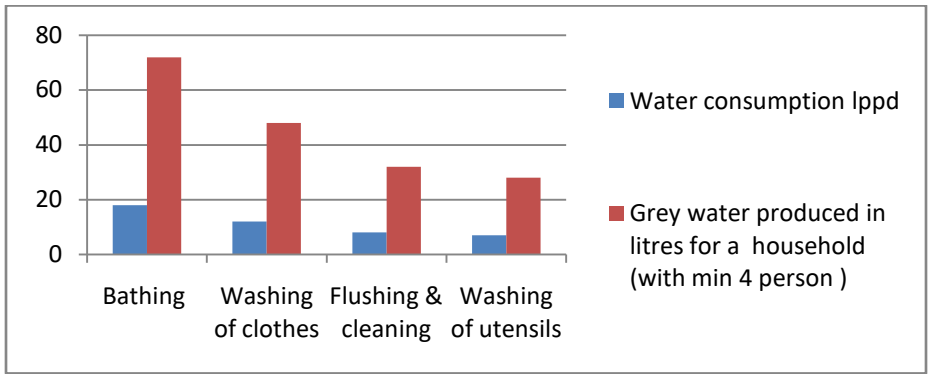


Fig 1.16–Grey water status for Chouldhari Panchayat

Therefore, an amount of 180 litres per day will be produced from each household. The grey water such released from households can be easily treated by Upflow-downflow filter as prescribed by Guidance Manual-NEERI.

Conclusion:-

Addressing the water deficit in island regions like Chouldari requires balancing short-term infrastructure growth with long-term ecological management. By combining targeted water source expansion (+300,000 L/day), watershed conservation, and household greywater recycling (187,740 L/day), Chouldari Gram Panchayat can bridge its current 61% supply gap and establish a resilient, self-sustaining water supply for both domestic and agricultural needs through 2050. The challenge of rapidly growing water demand could be addressed further by creating awareness amongst villagers/consumers, in addition to developing more sources to provide adequate and clean water to every citizen in the area. Thus, strategies for efficient and sustainable development and management of water resources need be extended to ensure access to the limited water resources to adequately support the water distribution system as well as the irrigation requirement for future agricultural activities.

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