**Original Research Article**

**Declining Employment in Water Conservation: An Analysis of Water Management Programs in Ranchi, Jharkhand, India**

**Abstract**

This article examines the relationship between water conservation efforts and employment generation in the Ranchi district of Jharkhand, India, over a four-year period from 2020-21 to 2023-24. The Department of Rural Development, Government of Jharkhand, provides secondary data that are analyzed in this study using both exploratory and quantitative research methodologies. A linear regression analysis is utilized to evaluate the impact of time (years) on employment across various water conservation related activities, including water conservation, renovation of traditional water bodies, flood control, drought proofing, irrigation canals, irrigation facilities for marginalized groups (SC/ST/IAY/LR) and land development. The findings reveal a significant decline in employment opportunities, particularly in water conservation and irrigation-related sectors with negative trends evident in most categories. The key statistical indicators such as R squared values, t-statistics and confidence intervals are used to evaluate the strength and reliability of the regression models. The analysis shows that water conservation efforts, once a major source of rural employment have significantly decreased which emphasizes the need to reconsider legislation and resource allocation in order to revitalize these programs. The study concludes that sustainable employment generation in water conservation requires strategic interventions to adapt to changing priorities and to promote long-term economic and environmental sustainability in the region.
Keywords: Employment Generation, Water Conservation, Sustainability, Rural Development

JEL Classification: E24, O1, Q25, Q56

1. **Introduction**
Life on Earth and all of its ecosystems including natural systems, societies and economies depend on water. Though water covers 71% of Earth’s surface, freshwater makes up only 3% of the total and most of it is trapped in glaciers. In certain areas, the hydrological cycle which evaporation, precipitation and runoff lead to unequal rainfall and water scarcity. Global water supplies are under increasing threat due to factors like population expansion, industrialization, climate change, diminishing glaciers and poor water management. Moreover, the demand for energy and economic growth put further stress on water resources (Kurunthachalam, S. K, 2014). The increased demand for water has made it more important than ever to protect our water resources. It is anticipated that as the water level falls in the future, the need for them will increase substantially. Along with their patterns of use and resources, water resources must be managed sustainably and conserved. Water conservation can be achieved in a number of ways including logical policy, existing resources, mechanical auditing, rain water harvesting, de-salination projects, water reuse and strict regulations to adopt safe and conservative water adaptation policies. The goal is to save the planet and improve the quality and quantity of sustainable water (SK Kurunthachalam, 2014; A. Pani, I. Ghatak & P. Mishra, 2021).

The frequency of droughts in agricultural regions is increasing and urban areas are experiencing a growing water shortage. The decreasing availability of water per capita is a significant factor in India’s water crisis but the ineffective management of water resources also plays a crucial role. India stands as the third-largest exporter of groundwater through virtual water trade, however 52% of its wells are experiencing declines. In fact, if there are no changes, the condition of water availability will decline swiftly. According to the best estimations, India’s water demand will increase by twofold over availability by 2030, leaving millions of people facing acute water scarcity (NITI Aayog, 2019).

The availability of water has been seriously threatened in recent years by overuse, urbanization, industry, global warming and natural disasters. By 2050, there will likely be a 9.4 billion increase in the global population placing further strain on the supply of water (A. Rao, JS Laura & G. Dhania, 2024).

* 1. **Literature Review**

There is a concerning decrease in the amount of surface and groundwater resources available to sustain the growing demands of industries, services, agriculture and other emerging activities. However, efforts to conserve and manage water resources in India are fragmented and irrational, sometimes driven by the impulses of individual inhabitants or democratic organizations. The nation has been compelled to reconsider and evaluate the measures outlined in the National Water Policy as well as to artificially replenish reservoirs that have been preserved through natural cures (A. Pani, I. Ghatak & P. Mishra, 2021). Severe water scarcity emphasizes the importance of water footprint as a motivator for water conservation. The United Nations has established the “Sustainable Development Goals (SDGs) that focus on developing a sustainable lifestyle to reduce environmental effects and generate social and economic advantages. Since water is essential to sustainable development, sustainable water use is a component of the SDGs (RR. Weerasooriya, LPK Liyanage, et.al., 2021). It is suggested that learning the political process and the political implications of various water conservation programs provides perspectives on tactics and their potential efficacy. The shift to higher levels of water conservation is a political process (KP. Brown & DJ Hess, 2017).

There is a national groundwater crisis in India with 54% of wells experiencing a decline in water level due to overuse of groundwater. 600 million people already experience high to extreme water stress, 75% of households lack access to piped water and 84% of rural households lack access to drinking water. By 2030, the country’s water demand is expected to be twice the supply, resulting in a 6% loss in GDP (NITI Aayog, 2019). The India Water Vision – 2035 states that by 2035, India will apply global best practices and policies to enhance resilience and mitigate risks so that all water-related disasters and disruptions are predicted in advance. This will make India climate-smart in all areas of water management for its cities and citizens; agricultural, livestock & fisheries; manufacturing and service industries; and the broader rivers, water bodies, ecosystems and environment (B. Sharma, 2022). The programs such as water supply systems, drainage, sewage and sanitation that directly involve local people also serve to create jobs and prevent poverty and its social repercussions. Public works programs that include local beneficiaries directly and government investment can both reduce the risk of the water issue getting worse and boost the agriculture industry (Z. Karimi, 2018).

The integration of community engagement in ecotourism development and watershed conservation based on economic empowerment will foster greater economic effort and community independence in the pursuit of sustainable development objectives. The key to managing rural population towards a stable and sustainable economic circulation of the community involves the implementation of strategic policies and the integration of watershed management system through the optimization of the utilization of natural resources and the empowerment of the community’s economy (B. Surya, S. Syafri, et. al, 2020). The programs for watershed development have increased employment options which will support the stabilization of yearly earnings for farmers in general and landless people in particular. It is perfectly suited for creating jobs in rural areas and it has the ability to integrate land development with resource preservation efforts in nationally implemented government supported programs. Therefore, by combining a variety of land-based and non-land-based parameters, efforts should be made to organize activities in future watershed programs that aim to maximize the overall amount of employment on and off farms (B. Mondal, RN. Adhikari, et.al.). In order to achieve sustainable development in rural areas, it is necessary to conserve natural resources and effectively include the public in their sustainable use without causing harm, Reduced involvement and negligence from rural population indicate that water conservation activities have been scaled back and reorganized, which has decreased the amount of area under cultivation overall and reduced the advantages that are offered. Due to a growing population density and the advancement of contemporary marketing, some water reservoirs have been destroyed and turned into urban areas. The reasons behind all of these hazardous situations are extreme invasion, continuous exploitation and little engagement. They contribute to and amplify the issues of resource logging and water scarcity (P. Balamurugan, 2023). In India, 51% of the net sown land is rainfed and lacks guaranteed irrigation facilities, hence the main focus for water management in these areas should be on watershed improvement projects such as building farm ponds, contour trenches and check dams. From an Indian perspective, traditional water management techniques have shown to be effective in the past and remain so today. The ancient water collecting techniques that were used in the many Indian states are just as significant now as they were then, if not more so (K. Vohra & ML Franklin, 2021).

1. **Objectives of the Study**

The paper seeks to find the following:

* To quantify the strength of the relationship between years and employment using regression analysis.
* To assess the statistical significance of this relationship to determine whether the observed changes are meaningful or likely due to random variation.
* To evaluate the reliability of the regression model by analyzing key statistical indicators including R2, adjusted R2, p-values and confidence intervals.
* To provide insights into potential trends over time while identifying limitations in the model that may require further research.
1. **Research Methodology**
2. *Research Design*: The paper employs a quantitative research approach by utilizing a linear regression analysis to examine the relationship between time and employment provided. The research is exploratory in nature with the aim to identify whether a significant trend exists over time and to quantify the strength of this relationship.
3. *Data Collection*: The data for this study is obtained from secondary sources spanning a period of four years. The data is time-series in nature which reflects changes in employment provided across different points in time.
4. *Data Analysis*:
* Multiple R: It measures the strength and direction of the correlation between years and employment.
* R Square: It measures the proportion of the variance in the employment explained by the years.
* Adjusted R Square: It measures how well the model generalizes to other datasets.
* Standard Error: It measures the average distance that the observed values fall from the regression line which indicates the precision of the model.
* t-statistic and p-values: It measures the statistical significance of the model coefficients. P-values below 0.05 indicate statistical significance.
* Confidence intervals: 95% confidence intervals for both the intercept and the slope were calculated to estimate the range within which the true values are likely to fall.
1. **Results and Discussions**

Table 1. Work Category-wise Employment

|  |  |
| --- | --- |
| Work Category | Employment Provided |
| 2020-21 | 2021-22 | 2022-23 | 2023-24 |
| Water Conservation | 248072 | 163129 | 40604 | 31336 |
| Renovation of Traditional Water Bodies | 206 | 0 | 0 | 0 |
| Flood Control | 2441 | 153 | 84 | 0 |
| Drought Proofing | 3611 | 14248 | 9402 | 2425 |
| Irrigation Canals | 325258 | 237263 | 58637 | 24248 |
| Irrigation Facilities to SC/ST/IAY/LR | 6809927 | 6270552 | 5679099 | 5361367 |
| Land Development | 13063 | 3432 | 832 | 1327 |

Source: Department of Rural Development, Government of Jharkhand

Table 2. Water Conservation

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 248072 |
| 2021-22 | 163129 |
| 2022-23 | 40604 |
| 2023-24 | 31336 |

Table 3 Regression Model for Water Conservation

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.959564 |
| R Square | 0.920762 |
| Adjusted R Square | 0.881143 |
| Standard Error | 35841.99 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 313968.5 | 43897.29 | 7.152343 | 0.018993 | 125093.7 | 502843.3 | 125093.7 | 502843.3 |
| Years (x) | -77273.3 | 16029.03 | -4.82084 | 0.040436 | -146241 | -8305.97 | -146241 | -8305.97 |

Interpretation: The regression result indicates a strong statistically significant negative relationship between years and employment in water conservation. Employment decreases by approximately 77,273 jobs per year and 92% of the employment variation is explained by the year. Both the intercept and year coefficient are statistically significant which suggests that the decline in employment over time is unlikely due to chance.

Table 4. Renovation of Traditional Water Bodies

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 206 |
| 2021-22 | 0 |
| 2022-23 | 0 |
| 2023-24 | 0 |

Table 5 Regression Model for Traditional Water Bodies

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.774597 |
| R Square | 0.6 |
| Adjusted R Square | 0.4 |
| Standard Error | 79.78346 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 206 | 97.71438 | 2.108185 | 0.169545 | -214.431 | 626.431 | -214.431 | 626.431 |
| Years (x) | -61.8 | 35.68025 | -1.73205 | 0.225403 | -215.32 | 91.71971 | -215.32 | 91.71971 |

Interpretation: The regression model indicates a moderately strong negative relationship between years and employment with employment decreasing by 61.8 jobs per year. However, the model explains only 60% of the variability and both the intercept and slope are not statistically significant suggesting the results may not be reliable.

Table 6. Flood Control

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 2441 |
| 2021-22 | 153 |
| 2022-23 | 84 |
| 2023-24 | 0 |

Table 7 Regression Model for Flood Control

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.806915 |
| R Square | 0.651112 |
| Adjusted R Square | 0.476668 |
| Standard Error | 855.553 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 2517.5 | 1047.834 | 2.402575 | 0.138212 | -1990.97 | 7025.966 | -1990.97 | 7025.966 |
| Years (x) | -739.2 | 382.6149 | -1.93197 | 0.193085 | -2385.46 | 907.0591 | -2385.46 | 907.0591 |

Interpretation: The regression model shows a moderately strong relationship explaining 65.11% of the variability in the dependent variable. The intercept is not statistically significant and therefore, the model may not provide highly reliable predictions.

Table 8. Drought Proofing

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 3611 |
| 2021-22 | 14248 |
| 2022-23 | 9402 |
| 2023-24 | 2425 |

Table 9 Regression Model for Drought Proofing

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.198075 |
| R Square | 0.039234 |
| Adjusted R Square | -0.44115 |
| Standard Error | 6575.601 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 9522.5 | 8053.433 | 1.182415 | 0.358567 | -25128.6 | 44173.63 | -25128.6 | 44173.63 |
| Years (x) | -840.4 | 2940.698 | -0.28578 | 0.801925 | -13493.2 | 11812.4 | -13493.2 | 11812.4 |

Interpretation: The regression model shows a very weak statistically insignificant relationship between years and employment. The model explains only 3.92% of the variability and the negative R2 is negative which indicates the model to be not meaningful.

Table 10. Irrigation Canals

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 325258 |
| 2021-22 | 237263 |
| 2022-23 | 58637 |
| 2023-24 | 24248 |

Table 11 Regression Model for Irrigation Canals

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.971547 |
| R Square | 0.943904 |
| Adjusted R Square | 0.915857 |
| Standard Error | 41692.62 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 431765.5 | 51062.83 | 8.455574 | 0.0137 | 212059.9 | 651471.1 | 212059.9 | 651471.1 |
| Years (x) | -108166 | 18645.51 | -5.80116 | 0.028453 | -188391 | -27940.5 | -188391 | -27940.5 |

Interpretation: The regression model shows a strong statistically significant negative relationship between years and employment with the model explaining 94.39% of the variability. For each additional year, the employment decreases by about 1,08,166 units and both the intercept and slope are reliable based on their p-values. The model is robust and provides meaningful insights into the relationship between the variables.

Table 12. Irrigation Facilities to SC/ST/IAY/LR

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 6809927 |
| 2021-22 | 6270552 |
| 2022-23 | 5679099 |
| 2023-24 | 5361367 |

Table 13 Regression Model for SC/ST/IAY/LR

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.992861 |
| R Square | 0.985774 |
| Adjusted R Square | 0.978661 |
| Standard Error | 93778.07 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 7264520 | 114854.2 | 63.24992 | 0.00025 | 6770342 | 7758697 | 6770342 | 7758697 |
| Years (x) | -493713 | 41938.83 | -11.7722 | 0.007139 | -674162 | -313265 | -674162 | -313265 |

Interpretation: The regression model shows an exceptionally strong statistically significant negative relationship between years and employment. The model explains 98.58% of the variability and both the intercept and slope are highly reliable based on their p-values. Each additional year is associated with a decline of approximately 4,93,713 units in the employment. The model provides robust and meaningful insights into the relationship.

Table 14. Land Development

|  |  |
| --- | --- |
| Year (x) | Employment (y) |
| 2020-21 | 13063 |
| 2021-22 | 3432 |
| 2022-23 | 832 |
| 2023-24 | 1327 |

Table 15 Regression Model for Land Development

|  |
| --- |
| Regression Statistics |
| Multiple R | 0.854515 |
| R Square | 0.730197 |
| Adjusted R Square | 0.595295 |
| Standard Error | 3633.77 |
| Observations | 4 |
|  | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 14115.5 | 4450.442 | 3.171708 | 0.086677 | -5033.2 | 33264.2 | -5033.2 | 33264.2 |
| Years (x) | -3780.8 | 1625.071 | -2.32654 | 0.145485 | -10772.9 | 3211.318 | -10772.9 | 3211.318 |

Interpretation: The regression model shows a moderately strong relationship between years and employment explaining 73.02% of the variability. However, the model lacks statistical significance as both the intercept and years coefficient have p-values above 0.05. It suggests that the results may be due to chance. The model provides limited meaningful insights.

**Problems of Water Conservation Strategies**

* *Lack of Funding and Resources*: The lack of finance for many water conservation initiatives in rural areas limits their scope and effectiveness. This reduces the infrastructure’s long-term effectiveness by causing it to be incomplete or badly maintained.
* *Fragmented and Inefficient Policy Implementation*: Many regions have divided initiatives due to a lack of collaboration between various government departments and local entities addressing water conservation regulations. Uniform policies and overlapping jurisdictions might lead to inefficiency and misunderstanding.
* *Limited Public Awareness and Engagement*: Lack of community understanding and involvement is a major reason that water conservation initiatives frequently fail. The public’s lack of understanding of the value of water conservation may result in the poor adoption of techniques like rainwater harvesting and water-efficient agriculture.
* *Technological Barriers*: Advanced technology can be difficult to implement in places with limited access to energy, internet connectivity or specialized personnel such as solar-powered water pumps or automated irrigation monitoring. Modern water management techniques are thus less likely to be adopted.
* *Inequitable Access and Benefits*: Water conservation initiatives frequently result in a side effect of promoting some communities over others, depriving marginalized groups of access to upgraded water supplies and the jobs they create.
* *Institutional Weaknesses and Corruption*: Water conservation initiatives may be affected by administrative inefficiencies, poor management, or corruption in local government. The success of these strategies may be undermined by inappropriate funding distribution or delayed initiatives.
* *Insufficient Monitoring and Data Collection*: It is impossible to evaluate the effectiveness of water conservation initiatives without adequate monitoring. Poor decision-making and outcomes might result from a lack of trustworthy data on project performance, rainfall patterns and water usage.

**Suggestions to Improve Water Conservation Policies**

1. Water Conservation Policy Reforms
* *Public-Private Partnerships (PPPs)*: Encourage PPPs to develop water infrastructure like desalination plants and smart irrigations systems, creating jobs in maintenance and operations.
* *Community-Driven Water Projects*: Increase funding for local water initiatives like decentralized storage and check dams, empower communities and generate employment in project management and implementation.
* *Monitoring and Evaluation*: Establish a nation water database using digital tools such as sensors, satellite data to track water use and provide employment in data analysis and tech support.
* *Strict Water Usage Regulation*: Implement legislation to control water use, incentivize industries and agriculture to adopt water-efficient practices and generate jobs in auditing and technology.
1. Diversification of Employment through Technology and Green Energy
* *Digital Irrigation Monitoring*: Use of smart sensors and IoT for efficient water management, creation of jobs in system development, maintenance and data analytics.
* *Green Energy in Water Management*: Integrate solar-powered water pumps and wind-powered irrigation, promote sustainable water use and generate employment in installation, operations and technical support.
* *Sustainable Agriculture Practices*: Introduce water-efficient crops and precision farming, offer roles in agri-tech, crop research and farmer training.
* *Wastewater Recycling*: Develop decentralized wastewater treatment systems, create jobs in plant construction, maintenance and technical operations.

**Conclusion**

The study concludes that employment generation through water conservation initiatives in Ranchi has significantly declined over the study period. The regression analysis indicates a strong negative relationship between years and employment in most categories, particularly in water conservation, irrigation canals and irrigation facilities for marginalized groups. This decline could be attributed to the reallocation of resources to more beneficial initiatives and the evolving priorities of rural development programs. The results highlight the urgent need for strategic interventions to revive employment opportunities in water conservation-related activities to improve livelihoods and sustain environmental efforts in the region.

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