Economic Costs of Water Pollution on Rural Livelihood

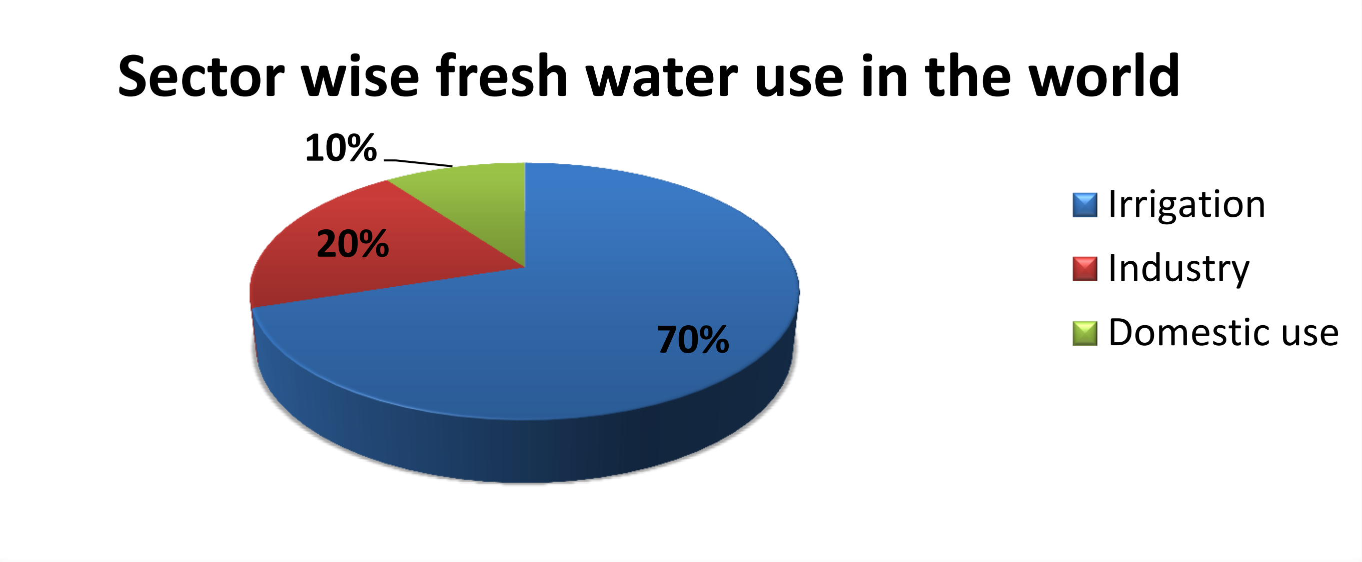
R.S. Poddar[1] and Shweta Byahatti[2]

[1]Professor (Agril. Economics) and Head, Project Planning and Monitoring Cell,
Office of the Vice-Chancellor, University of Agricultural Sciences,
Dharwad-580 005, Karnataka, India
Email: poddarrajendra@hotmail.com

[2]Graduate Assistant, University of Agricultural Sciences, Dharwad-580 005,
Karnataka, India, E-mail: shweta525byahatti@gmail.com

Introduction

- **A growing world population, unrelenting urbanization and increasing scarcity of water resources are the driving forces behind accelerating global demand for water.**
- **Water use has been growing at more than twice the rate of population increase in the last century (FAO).**



www.unwater.org/statistics/statistics-detail/en/c/211812/

Cont…

- Water scarcity already affects more than 40 per cent of the people on our planet. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions (FAO, 2012).

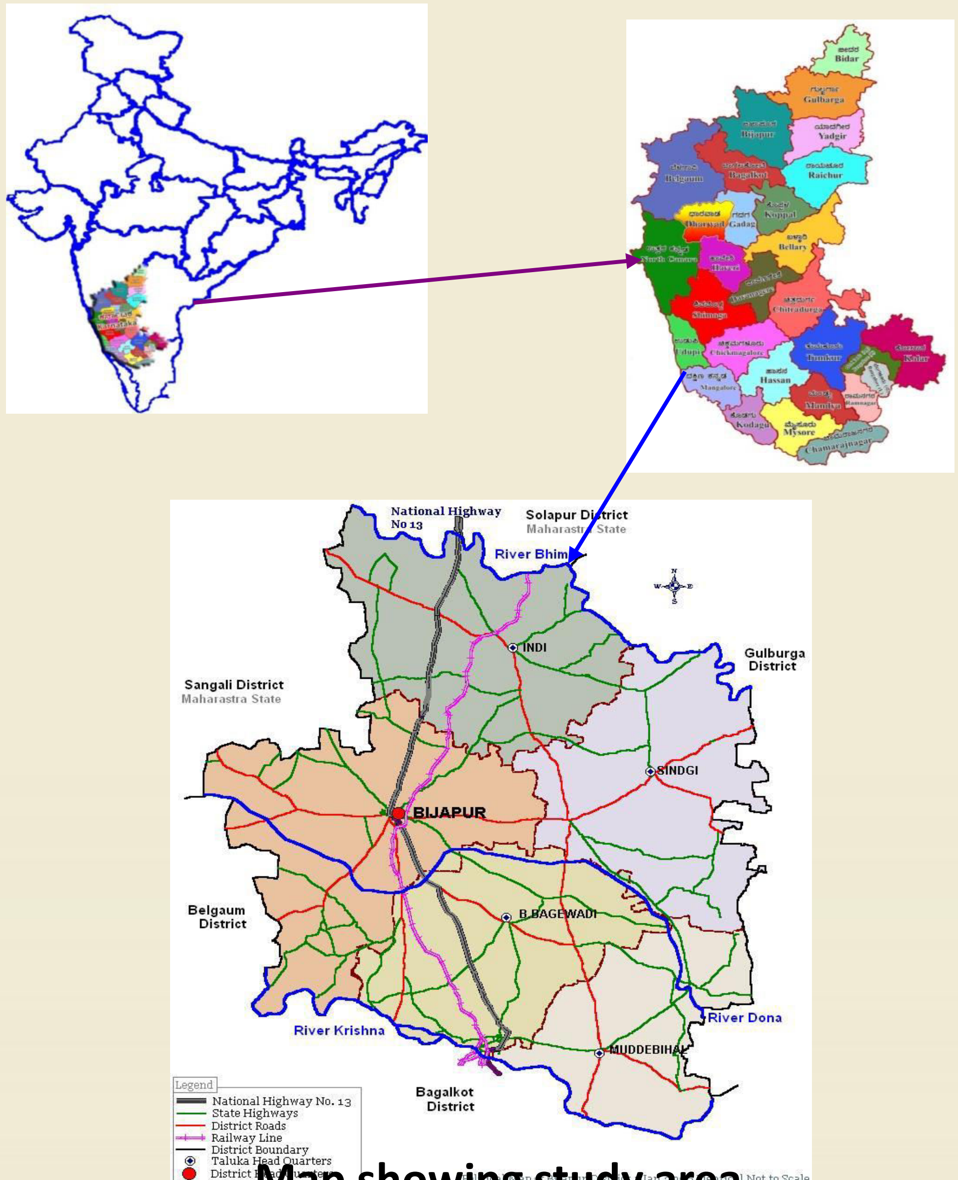
- Up to 90 per cent of wastewater in developing countries flows untreated into rivers, lakes and highly productive coastal zones (World Water Development Report, 2012).

- Over 80 per cent of wastewater worldwide is not collected or treated, and urban settlements are the main source of pollution (WWDR,2012).

- Water pollution has emerged as a serious problem in the recent times and is posing a greater threat to the environment.

- Most of the Indian rivers and their tributaries have grossly polluted due to discharge of untreated sewage disposal and industrial effluents directly into the rivers.

- According to quality analysis done by the Karnataka State Pollution Control Board (KSPCB) the Bhima River fell under category C, which means the water could be only be drunk with conventional treatment followed by disinfection.



Map showing study area

Pictures of water pollution in Bhima River and its tributaries

Bhima River

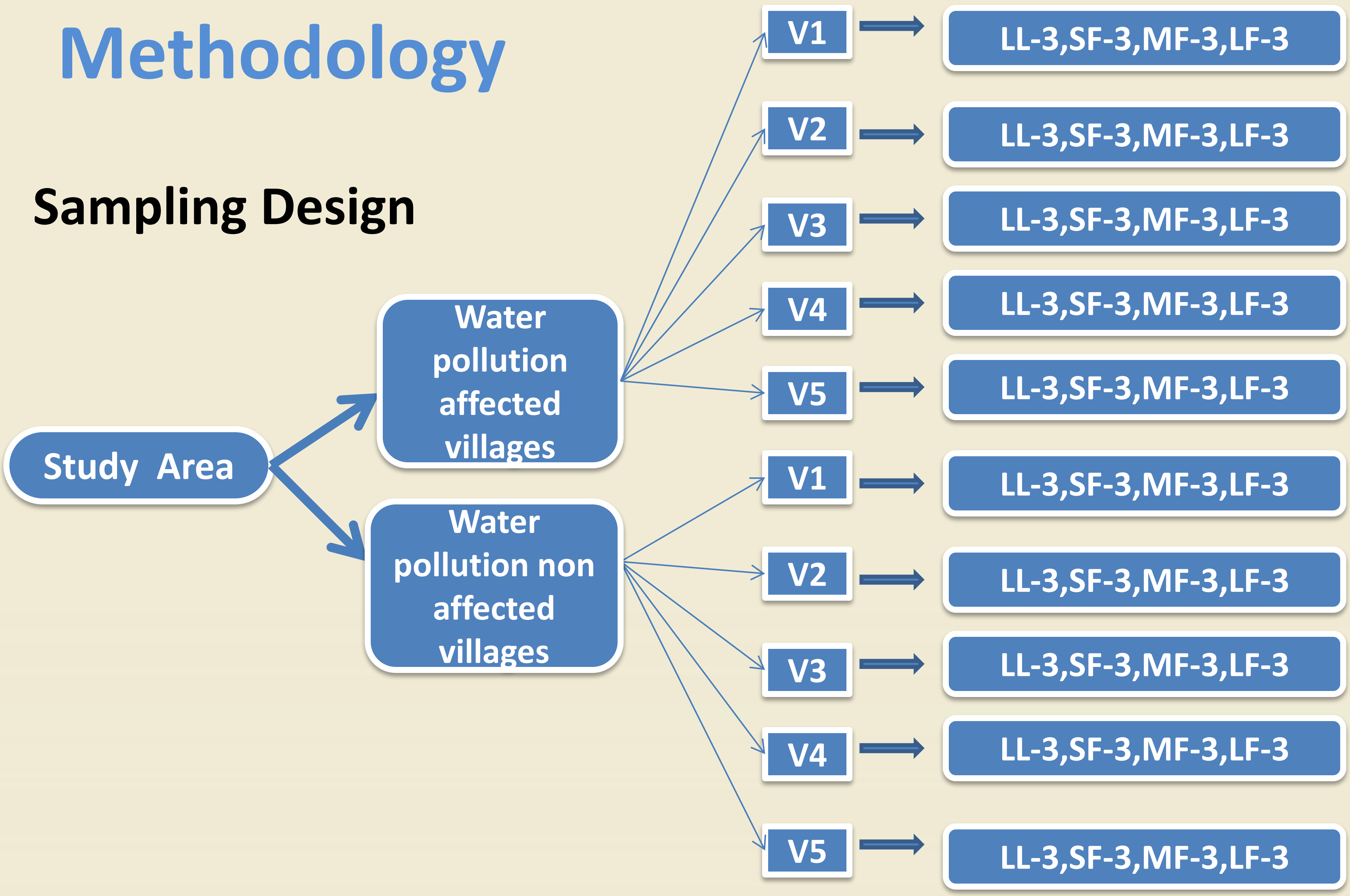
Objectives

- **To make an agro- biological assessment of river water quality.**

- **To assess the economic impact of river water quality on agriculture, livestock and rural livelihoods.**

Methodology

Sampling Design



Cont…

- To estimate water quality, water samples were collected from two polluted and two non polluted villages and tested for parameters and results of water samples tests were compared with Indian and WHO standards of water quality.
- Methods employed for the study included:
  - Logistic regression
  - Decomposition Model

Logistic Regression

- A logistic regression analysis was carried out to know the determinants of morbidity reported by the households.
- A dummy dependent variable assuming value 1 if the households report at least one sick member with skin itch, typhoid, diarrhea, fever which was major disease in the water polluted villages in reference period and otherwise zero has been generated.
- $Li = \ln (Pi / 1- Pi) = \beta 1 + \beta 2\ Vil\_c + \beta 3 Ow\_land + \beta 4 Ow\_livestock + \beta 5\ Edu\_head + \beta 6 agri\_lab + \beta 7 family\_size + \beta 8 avg\_age + \beta 9 fuel + \beta 10 mig\_lab + \beta 11 caste + \beta 12 pvt\_toilet.$

Decomposition Model

- It was aimed to decompose the change in productivity of a principal crop (sugarcane) between water polluted villages and water non polluted villages into the impact due to polluted water used for irrigation and that due to change in use of inputs.

Specifications of the model are as follows;

For non polluted villages

- $Y1 = a1\, X11^{b11} X12^{b12} \ldots\ldots\ldots\ldots\ldots\ldots X1n^{b1n} e$ ____________ (1)

For polluted villages

- $Y2 = a2\, X21^{b21}\, X22^{b22} \ldots\ldots\ldots\ldots\ldots\ldots X2n^{b2n} e$ ____________ (2)

Where,

- Y1 = Gross output obtained in non polluted villages
- Y2 = Gross output obtained on polluted villages
- a1 and a2 are the intercept of non polluted and polluted villages, respectively
- X1n = Independent variables in non polluted villages
- X2n = Independent variables in polluted villages

- For sugarcane the independent variables included,

X1 = Seeds (quintal)

X2 = Organic manure (quintal)

X3 = Human labour (man days)

X4 = Bullock labour (pair days)

X5 = Plant protection chemicals (Rs. /ha)

X6 = No. of irrigations

bi = output elasticity co-efficient of ith input

- Taking logarithm on both sides for equations 1, and 2,

ln Y1 = lna1+ b11lnX11+b12 lnX12 ………………. + b1n ln X1n __________ (3)

ln Y2 = lna2+b21lnX21+b22 lnX22 ………………. + b2n ln X2n __________ (4)

- To identify the structural break in the production relations that defined the yield levels in water polluted villages and water non polluted villages, **a dummy variable with 1 for water polluted villages and zero for water non polluted villages was introduced** in the production function of Cobb-Douglas setting.

- Decomposition Model for polluted V/s non polluted water was obtained by taking difference between equation (3) and (4).

- $(\ln Y2 - \ln Y1) = (\ln a2 - \ln a1) + \{(b21 \ln X21 - b11 \ln X11) + (b22 \ln X22 - b12 \ln X12) + \ldots\ldots + (b2n \ln X2n - b1n \ln X1n)$ ________ (5)

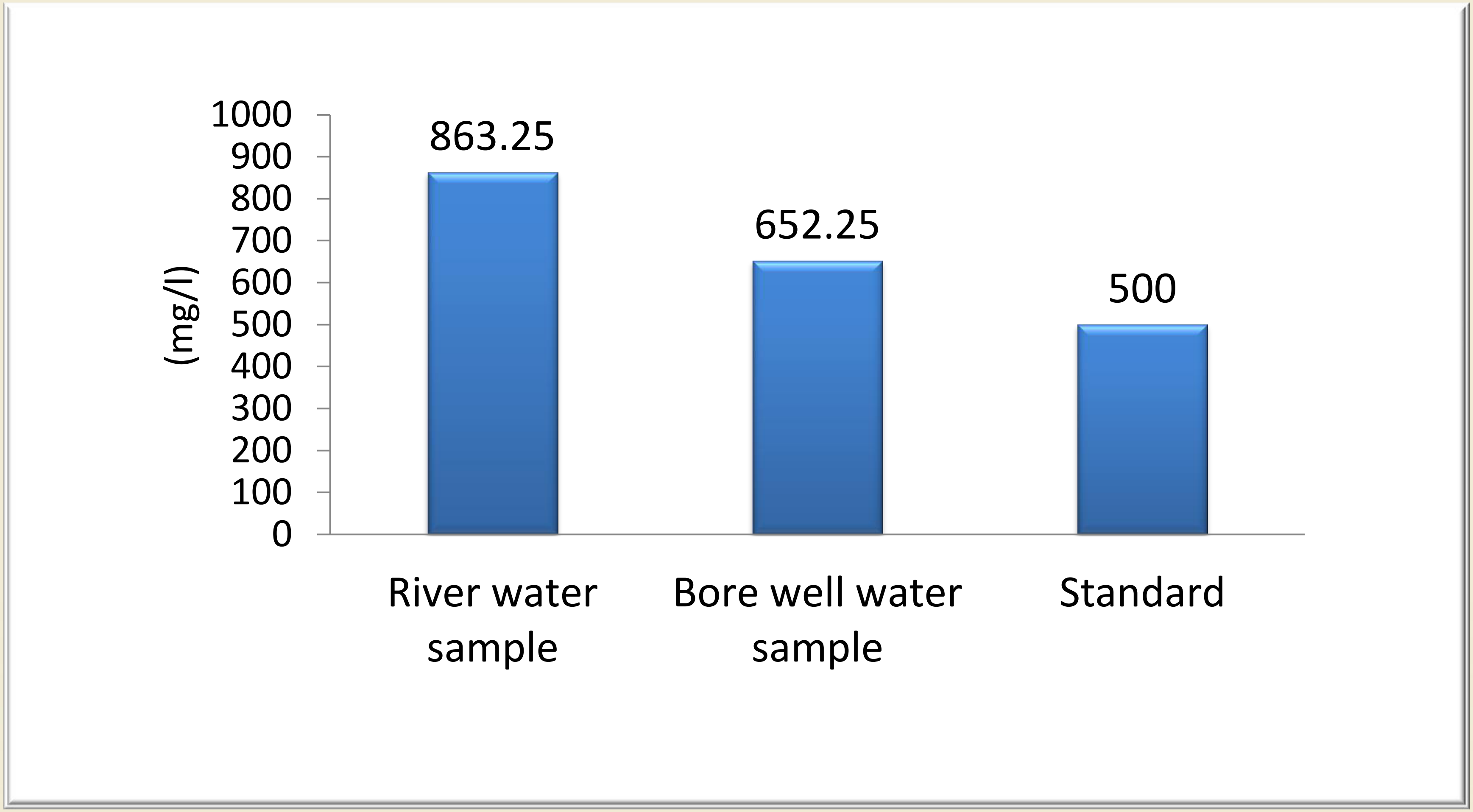


Fig.1 Total Dissolved Solid content in water samples

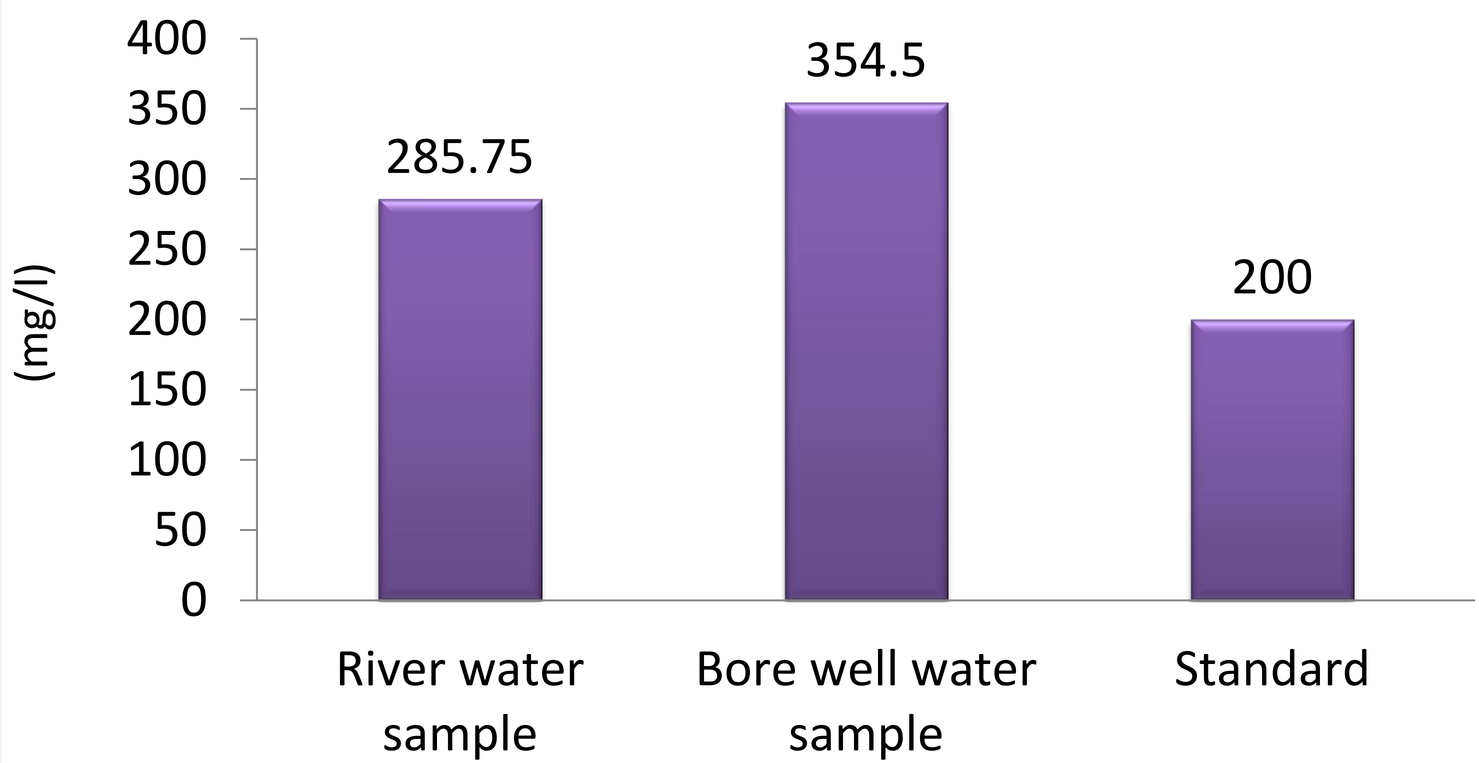


Fig. 2 Total Alkalinity in water samples

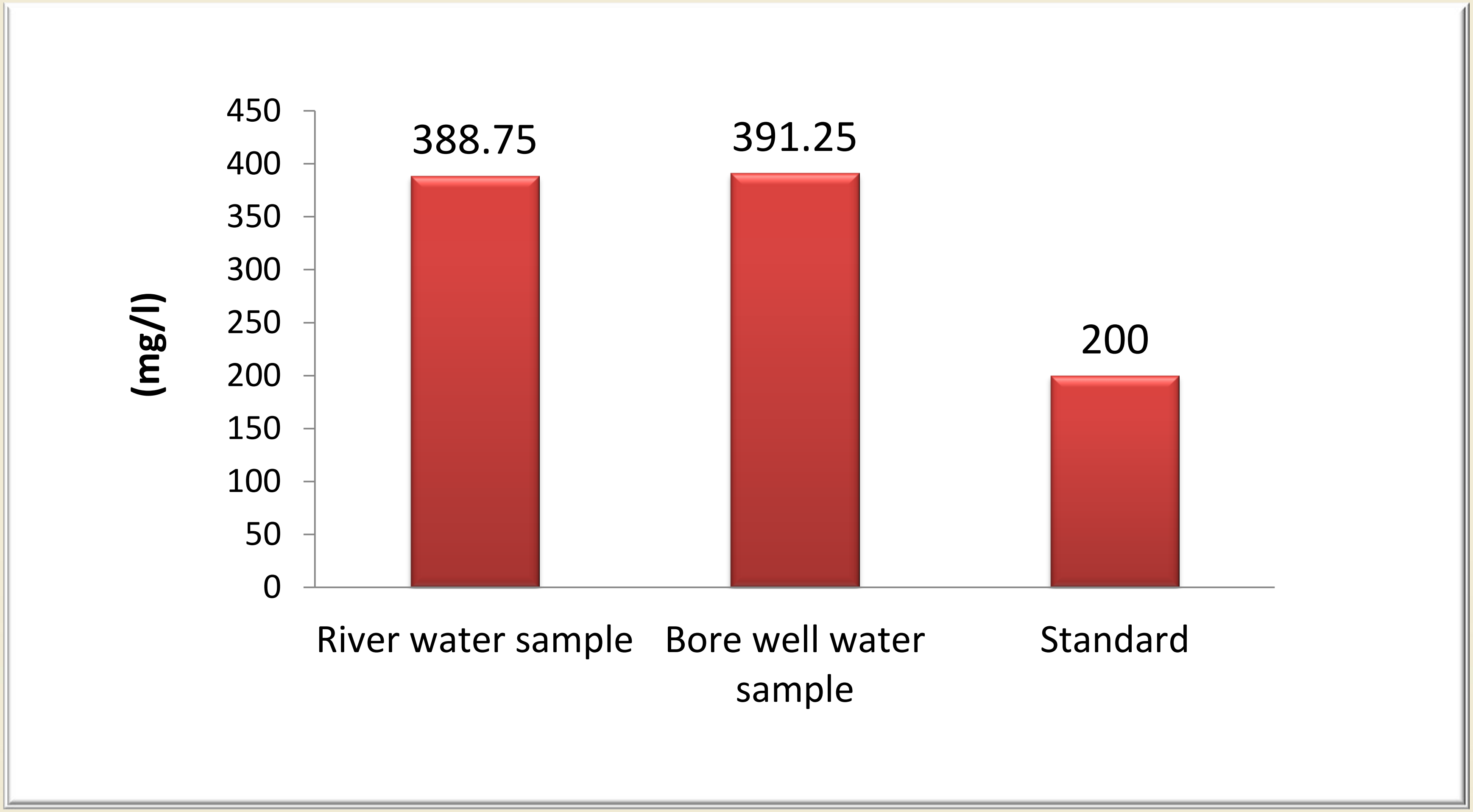


Fig. 3. Total Hardness in water samples

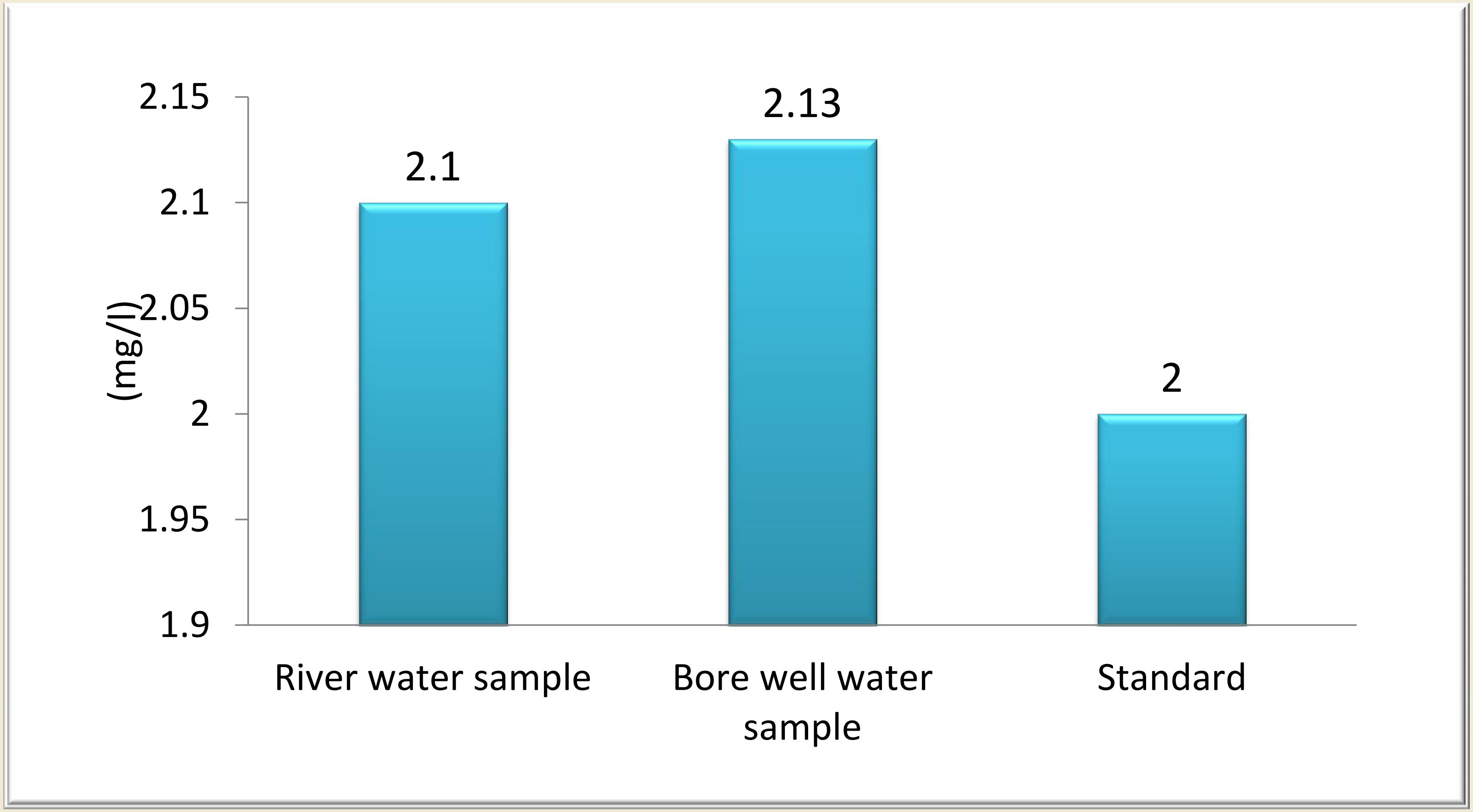


Fig. 4 Biological Oxygen Demand in water samples

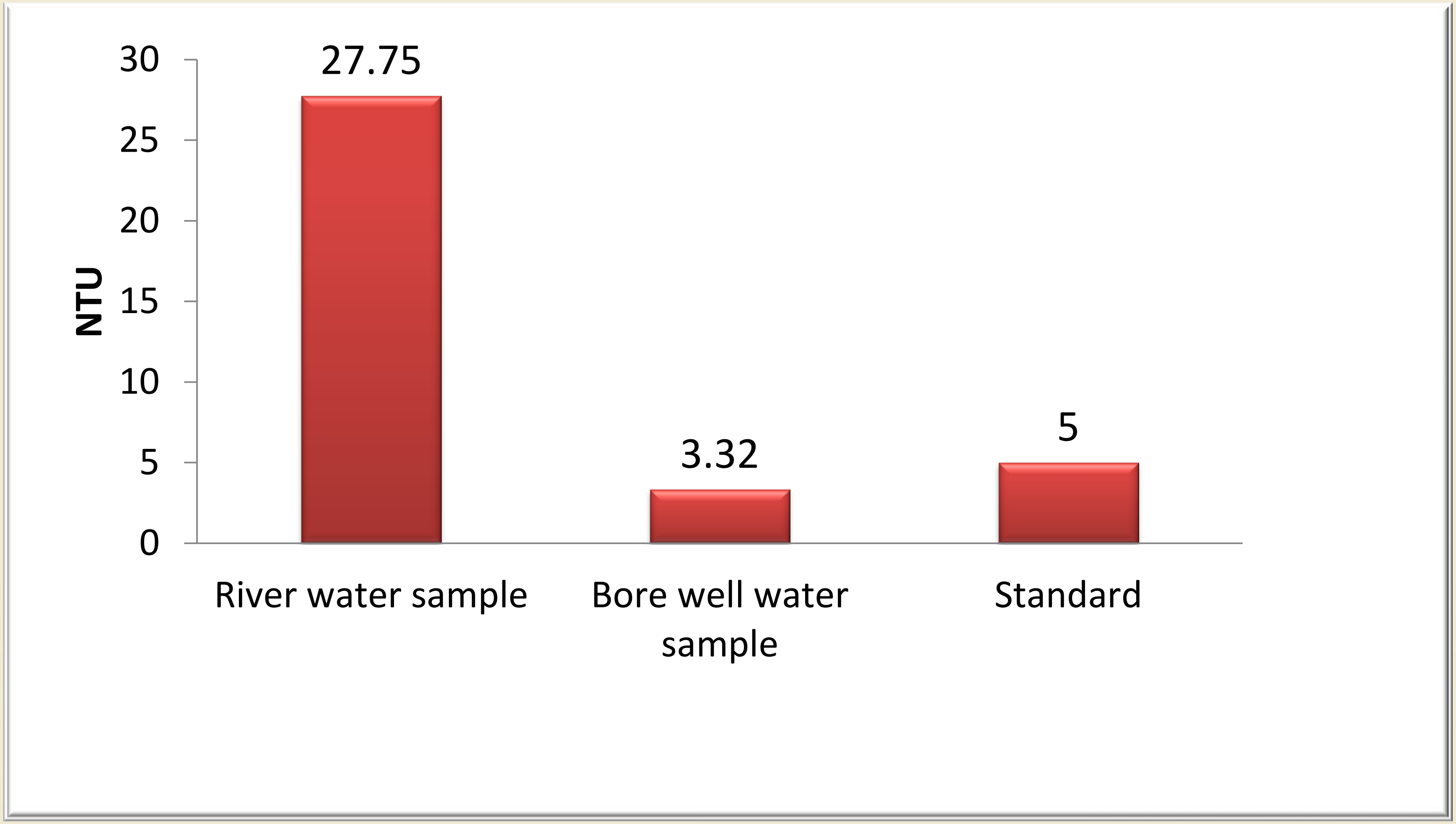


Fig. 5 Turbidity in water samples (NTU)

NTU = Naptholometric Furgibility Unit

Table 1: Decomposition of total difference in productivity of sugarcane crop in polluted and non polluted villages

Sl. No	Source of Difference	Percentage contribution
I	Due to polluted water	-0.88
II	Due to difference in input use	
	Seeds	-0.11
	Organic manure	0.67
	Human labour	0.36
	Bullock labour	3.24
	Plant Protection Chemicals	-0.37
	No. of irrigation	9.31
III	Total due to inputs	13.10
	Total difference in output due to all sources	12.22

Table 2: Yield and income losses in sugarcane crop

Villages	Yield difference (tonnes/ ha)	Income loss (₹)
Dhulkhed and Yelgi	3.56	6,408
Bhuyar and Hirebevnur	3.38	6,084
Lachyan and Baragudi	2.44	4,392
Shirnal and Halasangi	3.78	6,804
Chanegaon and Mananklagi	4	7,200

Table 3: Determinants of morbidity

	Coefficients	t-value
Vil_c	7.528	4.590**
Ow_land	-1.719	-1.036
Ow_livestock	1.789	0.779
Edu_head	-0.062	-0.626
agri_lab	0.11	0.096
family_size	-0.066	-0.623
avg_age	-0.009	-0.153
Fuel	-0.303	-0.267
mig_lab	0.315	0.203
Caste	-1.164	-0.897
pvt_toilet.	-1.354	-0.853
Constant	-1.348	-0.339

** Significant at 5 percent of significance level

Table 4: Economic Impact of Water Pollution

Source	Non polluted villages (₹)	Polluted villages (₹)	Difference	% Difference
Loss on agriculture	26,136 (66.23)	32,313.61 (64.42)	6,177.6 (57.74)	23.63
Loss of Employment	5,760 (14.59)	7,935 (15.82)	2,175 (20.33)	37.76
Loss on Human Health	7,050 (17.86)	8,196.66 (16.34)	1,146.66 (10.71)	16.26
Loss on Livestock Health	511.33 (1.29)	1,710 (3.40)	1,198.67 (11.20)	34.42
Total	39,457.33 (100)	50,155.27 (100)	10,697.93 (100)	27.11

Figures in the brackets indicate percentage

Conclusion

- Impact of consumption of Bhima river water had moderate negative effects on agriculture and rural livelihoods.
- If unchecked the degree of pollution in the river is expected to rise in the future.
- Study found that overall livelihood of farmers was negatively impacted by the polluted water. Reduced incomes and employment and increased expenditures on health of human beings and livestock caused a general loss in livelihood status.

Policy Implications

- The Karnataka State Pollution Control Board (KSPCB) has to expand its capabilities to continuously monitor river water quality in the state and laws should be strengthened to punish the guilty.
- Local government agencies should undertake regular water auditing for industries.
- Formulating integrated waste management programme to make sure that industrial waste does not contribute to the contamination of water.

- **Local community organizations** should be strengthened and trained for social monitoring of surface and ground water bodies on a regular basis.
- Appropriate ameliorating measures should be initiated to insulate the farm house holds from adverse effects of water pollution on their agriculture and livelihoods.

Cont...

- India needs to evolve a sound River Policy for protection of its invaluable water resources.
- Academia and research bodies should focus on social cost of pollution of water bodies to convince the policy makers.


Thank you!