SUMMARY
Wainganga River originates from the Paraswara mountains at an altitude of 450 meters above mean sea level, and flows down to 300 meters into the plains, between Seoni and Chhindwara districts. The River site adjacent to the Seoni appears to be seasonal with a small fast flowing ephemeral stream which dwindles or stops
flowing in summer. The water supply to Seoni town was from a small dam constructed at Lakhanwara to impound the River at this place.

The present distillery was situated in the outskirts of Seoni town and discharged its untreated effluent into the tributary of the River, which confluences with the River just below the impoundment. The distillery was shifted elsewhere in September, 87; therefore the whole communication categorised as: distillery operation period (From January 87 to September 87) and Distillery closed (October 87 to December 88). Apart from the distillery another factory vegetable oil refinery released crude oily sludge into a stream. The stream mixed with the River after flowing about 14 kilometers.

The monthly and fortnightly water samples were collected from nine sampling stations, were established for the study. Throughout the course of analysis were performed as per the procedures detailed in Standard Methods for Examination of Water and Waste water (1980), and Methods for Chemical Analysis of Fresh water (Golterman and Clymo, 1971).

Seoni distillery discharged dark brown, hot (48 °C), acidic, effluent contained high percentage of dissolved inorganic and organic matter which contributed toxicity to the effluent, consequently no life was found in the effluent. DO was completely absent with great amount
of BOD<sub>5</sub> and COD. All physical and chemical parameters were always beyond the limit of ISI: 2490: 1974 in the effluents.

The distance and dilution of the effluent enabled the reduction of pollution loading, before its outfall to the River. Distillery waste showed 77.2 to 88.59% recovery after flowing about 10 kilometer from station PD to station D. Improvement in DO levels and pH values was also recorded from 0.0 - 1.7 ppm and 4.5 to 7.48 respectively. Still, the values of different factors were 2.94 to 18.12 times greater in comparison to control station W<sub>1</sub>.

The distillery effluent added high concentration of organic matter to the River which was responsible for remarkable decrease in DO (7.7 to 5.5 ppm) and pH (8.04 - 7.85) along with increase in BOD<sub>5</sub>, COD and TSS with other factors substantiated impact of the effluent on the River water. Water temperature of the effluent did not appear to have no impact on the River and changed costomarily seasonal.

The effluent mainly contributed total suspended solids from total solids to the River. TSS showed strong positive relationship (p < 0.001) with chloride (r = 0.74), turbidity (r = 0.53) and COD (r = 0.54); and inverse correlation coefficient with BOD (r = -0.90), TS (r = -0.99) and SO<sub>4</sub> (r = -0.55). The distillery effluent also contributed dark brownish colour to the River was so obvious making it undesirable for various purposes. Further,
the obnoxious odour emitted made the lives of the nearest dwellers miserable.

Anaerobic conditions were recorded during number of occasions, mainly influenced by water temperature \( (p \leq 0.05) \) and BOD \( (p \leq 0.05) \). Lowest DO values in the system were recorded in summer with highest water temperature \( 35 \, ^\circ \text{C} \). Deoxygenation indicating that the rate of oxygen replenishment was lower than of utilization which was recorded during most of the sampling occasions at station D.

Recovery station W3 exhibited improvement in DO level by its turbulent flow, indicating a good reaeration capacity of the River. DO showed strong negative relationship \( (p \leq 0.001) \) with ammonia nitrogen, nitrate & nitrite nitrogen and biochemical oxygen demand.

As the River runs for about 3 kilometer BOD reduced 40 % indicating tremendous self-purification capacity of the River with 31 % reduction in TSS. COD was more than two times greater than BOD but declined only 9.1 % in the River indicating lesser chemical oxidation than biochemical oxidation.

Addition of acidic waste to the River destroyed buffering capacity of the ecosystem, and pH fall sharply. Alkalinity presence was mainly due to bicarbonates and very little amount of carbonates
while carbonate alkalinity was absent throughout in distillery operation period at station \( W_2 \). Higher alkalinity in comparison to hardness indicating presence of noncarbonate hardness.

Calcium, magnesium, sodium, potassium, chloride, nitrate nitrogen did not show any recovery contrary they increased at station \( W_3 \) with conductivity, this might be due to reduction in flow.

Chloride and nitrogen have been recognised as water pollutants for a long time, were increased in the River water after the addition of the effluent. The mean values of \( \text{NH}_3^-\text{N} \) showing gradual decline towards downstream may be due to rapid assimilation of ammonical-nitrogen than nitrate & nitrite nitrogen. \( \text{Ca}^{++} \) and \( \text{HCO}_3^- \) were dominated cations and anions, ranked as \( \text{Ca}^{++} > \text{Mg}^{++} > \text{Na}^+ > \text{K}^+ \) and \( \text{HCO}_3^- > \text{SO}_4^{--} > \text{Cl}^- > \text{CO}_3^- > \text{PO}_4^{3--} \) respectively. The above pattern was maintained throughout the observations.

After the closing of the distillery the observations reflected that the River has enormous capacity of self-purification. Maximum BOD, COD and TSS were recovered within three months. DO increased significantly 150 to 178 % in the River water which was greater than that of upstream, thereon it decreases to nearly 100 %, and saturation was still maintained to last observation.

Excessive nitrogen in the River water promotes the massive algal growth resulted significant increase in DO. Though, the
concentration of nitrogen was higher in River water during distillery operation period but co-existed with other toxicants which limits the algal growth. Massive algal patches also recorded on the surface of the River water in October, November and December 87.

Carbonate alkalinity was recorded throughout from March 88 to last observation might be due to increase in photosynthetic activity of organisms.

Nitrogen complex tend to declined gradually but the value of calcium, magnesium, sodium, potassium and chloride followed a general trend increase in summer and the values declined in monsoon due to dilution.

BOD, COD, TSS, DO and some other factors were completely recovered within a period of three to seven months, while ionic concentration remained high still last observation indicating long term impact on the River.

The oil refinery at Seoni released emulsified, highly acidic (2.2-6.0) effluent contained higher concentration of hardness, calcium, magnesium, chloride, sulphate, phosphate, sodium and total solids. Data reveals its highly toxic nature even after flowing more than 3 kilometer at station R1. Free CO2 recorded was greater at station R1 during most of the sampling occasions, due to decomposition of organic matter.
Calcium, magnesium, sulphate, phosphate with other factors showing slight improvement at station R₁. The distance traveled by the effluent and dilution much reduced the effect of the effluent before its outfall to the River. Refinery station R₂ contained 7 to 64 times greater values of different variables in comparison to control station W₁. Since, the station W₃ already rich in pollutants, showed dilution at station W₄ after the addition of refinery effluent.

pH showed (highly alkaline) critical range of the values at station R₂, contrary station R₁ was highly acidic. Immediate decline in pollutants at further, downstream station W₄ was may be due to dilution and dissociation of ionic activities.

The effluent discharged from distillery and refinery were highly toxic and serious health hazardous for rural and urban people of surrounding areas. Both of these effluent having tributaries encircled Seoni town 4 to 6 kilometer before its discharged to the river. Undesirable dark brownish colour and obnoxious odour of distillery effluent; and unsighted floating whitish black matter and oily film on the refinery effluent heinously making it bad to worst.

Further, obnoxious odour emitted throughout the year made the lives of the nearest people painful. Conditions were found to be deteriorating in summer, when environmental temperature increased
to 42 °C combining with concentration of the wastes and rapid
decomposition of organic matter.

Algal periphyton community comprises diverse flora of 84 species
of different algal groups. Bacillariophyceae dominated throughout
with 54 species followed by chlorophyceae (19), cyanophyceae
(8), euglenophyceae (2) and rhodophyceae (1).

Bacillariophyceae contributed 69.2 to 97.08 % and revealed marked
difference at polluted sites Nitzschia palea and Navicula
rhyncocephala were distributed at all sampling stations and showed
their dominance in the group. The species of Nitzschia, Navicula
and Gomphonema were accompanied and confined at distillery effluent
impacted stations.

Nitzschia palea, N. acicularis, Synedra ulna, Navicula rhyncocephala,
N. pupula, Pleurosigma salinarum, Gomphonema ventricosum, Cymbella
ehrenbergi were recorded in polysaprobic zone. Navicula pygmea
was suddenly appeared with highly acidic pH (2.44 - 3.28),
afterwards it shows complete disappearance. N. palea, Frazillaria
intermedia, Diatoma elongata, Pleurosigma spp., Gomphonema
ventricosum were also recorded at this pH.

Association of Nitzschia and Navicula were accompanied in acidic
conditions during the present studies. Diatom showing correlation
with hardness \((p \leq 0.05)\) are the indicator of hardwater. Algal diversity index (Shanon & Weaver, 1948) was significantly lower \((\bar{d} = 0.8 \text{ at station } W_2\) and \(\bar{d} = 0.95 \text{ at } W_4\) \) indicating heavy pollution, while station \(W_3\) moderately polluted \((\bar{d} = 1.69 - 2.87)\).

Nutrients prominent to stimulate excess algal growth immediate after the close of distillery and cause eutrophication.

The green algae was co-dominant group \((0.73 - 23.7 \%)\). Healthier growth of chlorophyceae was associated by favourable water temperature \((p \leq 0.01)\). DO significantly \((150-178\%)\) increased in River water with optimum growth of \textit{Stigeoclonium tenue}, \textit{Ulothrix} spp. and \textit{Cladophora} spp.

\textit{Cyanophyceae} \((0.12 - 6.49 \%)\) generally consisted of \textit{Oscillatoria} spp. \textit{Nostoc} spp, \textit{Anabaena} spp., \textit{Nodularia} spp. This group showed very strong positive relationship with TSS \((p \leq 0.001)\).

A rare species of \textit{Audeonella violacea} was recorded June to August, 87 only at station D.

During the distillery operation period environment of the lotic ecosystem was badly imbalanced consequently only pollution tolerance species of the organisms were found to be survived. Fishes were never recorded from these impacted stations but represented by mollusc species of \textit{Viviperus bengalensis}, \textit{Lymnea acuminata}. 

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Melynoës spp.

Zooplankton were mainly represented by Filinia longiseta, Notholca accuminata, Brachionus calyciflorus, B. fulcatus, Lecane spp, Monostyla spp (Rotifera); Cyclops spp (Cladocera); Arcella discoïdes, Vorticella spp. (Protozoa); and Chironomus and Nauplius larvae.

Macrophytic vegetation Chara, Vallisneria, Equisetum were recorded at station D. However Vallisneria was distributed throughout in the River but Nitella confined to station W 2 only.

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