An Unprecedented Initiative for Rivers of India

Started: April 2019
Agenda

1. Atulya Ganga Project: Overview
2. Pollution Mapping: 2020-21
3. Mobile App for Pollution Mapping
4. Atulya Ganga Project: Road Map
Atulya Ganga Project
2020 - 2031

Our Aim
Monitoring River Ganga pollution levels to drive improvement for the next 10 years and create an exemplary model for other rivers.

Our Mission
Synergise all resources of the Government, NGOs, Volunteer Organisations and General public for revitalisation of River Ganga.

Our Vision
Rejuvenation and restoration of Indian Rivers for future generations.
Atulya Ganga Project: Our USP

A committed, apolitical, secular, non-discriminatory and non-hierarchical organization mainly of military veterans with Ganga as single point agenda. Our goal is to undertake regular activities such as walkathons, cyclothons, plantation drives to provide a unique platform for a number of path breaking initiatives – such as water pollution mapping, awareness camps, geo-tagging items of interest like monuments, flora, fauna, and historical monuments along the entire river.

➢ An independent 3rd party audit.
➢ Yearly detailed water sampling plan from origin to the estuary of the river - to serve as a model for other rivers in our country and beyond.
➢ Adherence to international protocols of water sampling.
➢ In-situ testing with field testing kit and laboratory testing for balance water parameters.
➢ Raising public awareness about pollution levels in the entire river basin leveraging technology through mobile apps, AI and IOT (Internet of Things).
➢ Annual water pollution reports with detailed findings, analysis and recommendations submitted to the Governing authorities.
Atulya Ganga Project: 11-Year Plan

Yearly Activities
- Parikrama of River Ganga and its tributaries.
- Water Sample Testing, calculating water quality index to monitor pollution levels.
- Data Collection and Analytics of all aspects covered by the project.
- Sustainable plantation i.e., wilding both banks of River Ganga.
- Demarcation of boundary of River Ganga to avoid encroachment.
- Holding of Awareness programs, brainstorming sessions/conferences.

Empowerment Program
- Preparation and maintenance of mobile app and Ganga Health Dashboard for general public use.
- Advise and maintain cleanliness of Ghats/Riverfronts/Surroundings.
- Empowering of Nishad/Fishermen Community.
- Introduction of a chapter in restoration of rivers in school and college syllabus.
Atulya Ganga Project: Founding Members

Gopal Sharma
(Ace Mountaineer)

Lt Col. Hem Lohumi SM (Retd)
A multifaceted adventurer

Col. Manoj Keshwar (Retd)
Leading adventure organiser
Atulya Ganga Project: Ganga Health Dashboard Team

Maj Gen VK Bhatt
Environment Adventure & Sports Expert

Dr (Col) Kailash Tiwari
Delhi Technological University

Dr Rasik Ravindra
Glaciers & Ocean Expert

Dr Vijay Loganathan
Asst Professor, IIT Ropar

Maj Gen Soma Pillai
Champion Sailor, Geo-mapping Expert

Mohit Verma
PHD Scholar IIT Ropar, Tech Guru
Achievements in the past 3 Years
(with limited funds and Covid-19)

<table>
<thead>
<tr>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Registration of Atulya Ganga Trust</td>
<td>✓ Mundmal Parikrama (walkathon) of 5530km in 190 days</td>
<td>✓ Submission of first year water pollution report giving findings and recommendations to Ministry of Jal Shakti and National Green Tribunal (NGT)</td>
</tr>
<tr>
<td>✓ Preparatory ground-work of mobile app and Ganga Health Dashboard</td>
<td>✓ Pollution mapping of River Ganga at 224 Points</td>
<td>✓ Atulya Ganga Cyclothon of 2800 km from Gangotri to Gangasagar in 28 days.</td>
</tr>
<tr>
<td>✓ Capacity building for water sampling and testing to Ganga Praharis</td>
<td>✓ Development of novel model for analysis of Water Quality data.</td>
<td>✓ 2nd Year Water Pollution Testing for Entire Ganga at 150 places.</td>
</tr>
<tr>
<td>✓ Training for Mundmaal Parikrama (Walkathon)</td>
<td>✓ Awareness camps in major cities, towns, schools, colleges to generate Jan Andolan.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ Submitted reports to Ministry of Tourism on Places of Tourist Interest / Historical Significance.</td>
<td></td>
</tr>
</tbody>
</table>
Mundmal Parikrama: 2020-21
Plantation: 2020-21

- Green India Foundation
- Vriskshmaal Project
- Geo-tagged Saplings
- Mentor Fixed
- 30,000+ Trees
Awareness Campaign

Time to fix accountability for Ganga cleaning, says National Green Tribunal

Observing that the challenge of cleaning Ganga remains despite monitoring for the past 36 years, the National Green Tribunal said that it is time to fix accountability for proper and timely utilisation of funds allocated for cleaning the river.
Snapshots
Pollution Mapping: 2021

- App Under Development
- Ganga Health Dashboard
- 224 River Water Samples
- 600 + Nallas Geo-tagged
- Established Water Quality Index
- Publication in International Journal
## Basic Pollution Parameters Tested

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Class -A</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>Turbidity (mg/L)</td>
<td>10</td>
</tr>
<tr>
<td>Hardness (mg/L)</td>
<td>300</td>
</tr>
<tr>
<td>Chlorides (mg/L)</td>
<td>250</td>
</tr>
<tr>
<td>Fluorides (mg/L)</td>
<td>1.5</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>6.0-14</td>
</tr>
<tr>
<td>TDS (mg/L)</td>
<td>500</td>
</tr>
</tbody>
</table>

## Water Quality Index Based on Tested Parameters

<table>
<thead>
<tr>
<th>Ser no.</th>
<th>MWQI</th>
<th>Class</th>
<th>Water Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>I</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>&lt;100-80</td>
<td>II</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>&lt;80-50</td>
<td>III</td>
<td>Fair</td>
</tr>
<tr>
<td>4</td>
<td>&lt;50-20</td>
<td>IV</td>
<td>Poor</td>
</tr>
<tr>
<td>5</td>
<td>&lt;20-0</td>
<td>V</td>
<td>Heavily polluted</td>
</tr>
</tbody>
</table>
Pollution Mapping: 2021

Geo-tagged pollution levels

Findings:
• Excellent Quality (WQI : 100) – 44 locations
• Good Quality (WQI : <100-80) – 121 locations
• Fair Quality (WQI : <80-50) – 13 locations
• Poor Quality (WQI : <50-20) – 31 locations
• Heavily Polluted (WQI : <20) – 10 locations
### Pollution Mapping: 2021

**Heavily Polluted Locations (Hot Spots – 2021) : Class V**

<table>
<thead>
<tr>
<th>Ser No</th>
<th>Table S. No.</th>
<th>Name of City/Town</th>
<th>Name of Place</th>
<th>WQI (&lt;20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>84</td>
<td>24 Parganna (P) Kakdwip, WB</td>
<td>Harwood Point</td>
<td>1.02</td>
</tr>
<tr>
<td>2</td>
<td>87</td>
<td>24 Parganna (P) Kakdwip, WB</td>
<td>PS Castle</td>
<td>1.02</td>
</tr>
<tr>
<td>3</td>
<td>83</td>
<td>24 Parganna (P), WB</td>
<td>Kulpi</td>
<td>3.38</td>
</tr>
<tr>
<td>4</td>
<td>82</td>
<td>24 Parganna (S), WB</td>
<td>Durgapur</td>
<td>7.63</td>
</tr>
<tr>
<td>5</td>
<td>203</td>
<td>Bijnour, UP</td>
<td>Nabalpur Barage</td>
<td>16.28</td>
</tr>
<tr>
<td>6</td>
<td>205</td>
<td>Bulandshahr, UP</td>
<td>Rajghat Naraura</td>
<td>17.84</td>
</tr>
<tr>
<td>7</td>
<td>207</td>
<td>Aligarh, UP</td>
<td>Kachalaghat</td>
<td>17.84</td>
</tr>
<tr>
<td>8</td>
<td>79</td>
<td>24 Parganna(S), WB</td>
<td>Noorpur Ferry ghat</td>
<td>18.03</td>
</tr>
<tr>
<td>9</td>
<td>204</td>
<td>Bulandshahr, UP</td>
<td>Anoop Shahr</td>
<td>19.19</td>
</tr>
<tr>
<td>10</td>
<td>209</td>
<td>Kanpur, UP</td>
<td>Pettambra Peeth</td>
<td>20.01</td>
</tr>
</tbody>
</table>
### Pollution Mapping: 2021

#### Poor Quality Locations: Class IV

<table>
<thead>
<tr>
<th>Ser No</th>
<th>Table S.No.</th>
<th>Name : city/town</th>
<th>Name of place</th>
<th>WQI (&lt;50-20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>24 Parganna(S), WB</td>
<td>Nurpurghat</td>
<td>22.21</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
<td>24 Parganna(S), WB</td>
<td>Fatehpur Faita, PS</td>
<td>22.47</td>
</tr>
<tr>
<td>3</td>
<td>77</td>
<td>24 Parganna(S), WB</td>
<td>Fatehpur Raipur Ghat</td>
<td>27.27</td>
</tr>
<tr>
<td>4</td>
<td>211</td>
<td>Unnao, UP</td>
<td>Bighapur Karmi Garehwa</td>
<td>25.08</td>
</tr>
<tr>
<td>5</td>
<td>213</td>
<td>Raibareilly, UP</td>
<td>GokaranGhat</td>
<td>22.47</td>
</tr>
<tr>
<td>6</td>
<td>214</td>
<td>Raibareilly, UP</td>
<td>Kotraghat</td>
<td>27.27</td>
</tr>
<tr>
<td>7</td>
<td>221</td>
<td>Prayagraj, UP</td>
<td>Suressarghat</td>
<td>27.27</td>
</tr>
<tr>
<td>8</td>
<td>208</td>
<td>Kanpur, up</td>
<td>Shuklaganjan Ganga Br</td>
<td>29.45</td>
</tr>
<tr>
<td>9</td>
<td>222</td>
<td>Prayagraj, UP</td>
<td>JhunshiGhat</td>
<td>31.96</td>
</tr>
<tr>
<td>10</td>
<td>166</td>
<td>Fatehpur, UP</td>
<td>Manipuri Ghat</td>
<td>31.94</td>
</tr>
<tr>
<td>11</td>
<td>28</td>
<td>Chapra, Bihar</td>
<td>Chirand Bangli Baba Math</td>
<td>31.13</td>
</tr>
<tr>
<td>12</td>
<td>223</td>
<td>Prayagraj, UP</td>
<td>Kila Ghat</td>
<td>32.97</td>
</tr>
<tr>
<td>13</td>
<td>75</td>
<td>24 Parganna(N), WB</td>
<td>Dakshineshwar Temple Tilagarh</td>
<td>33.17</td>
</tr>
<tr>
<td>14</td>
<td>164</td>
<td>Prayagraj, UP</td>
<td>Kada Dham</td>
<td>33.42</td>
</tr>
<tr>
<td>15</td>
<td>165</td>
<td>Prayagraj, UP</td>
<td>Sato Police Station</td>
<td>33.43</td>
</tr>
<tr>
<td>16</td>
<td>167</td>
<td>Fatehpur, UP</td>
<td>Naubata Ghat</td>
<td>33.33</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>Prayagraj, UP</td>
<td>Gokul Ghat</td>
<td>33.74</td>
</tr>
<tr>
<td>18</td>
<td>74</td>
<td>24 Parganna (N), WB</td>
<td>Tilagarh Ind Waste Nalah</td>
<td>33.85</td>
</tr>
<tr>
<td>19</td>
<td>37</td>
<td>Begusarai, Bihar</td>
<td>Kharampura Ghat</td>
<td>33.85</td>
</tr>
<tr>
<td>20</td>
<td>76</td>
<td>24 Parganna (N), WB</td>
<td>Tilagarh Balu Ghat</td>
<td>33.85</td>
</tr>
<tr>
<td>21</td>
<td>169</td>
<td>Fatehpur, UP</td>
<td>Suripur</td>
<td>33.43</td>
</tr>
<tr>
<td>22</td>
<td>219</td>
<td>Pratapgarh, UP</td>
<td>Kunda Shrengusarpur Ghat</td>
<td>33.45</td>
</tr>
<tr>
<td>23</td>
<td>217</td>
<td>Pratapgarh, UP</td>
<td>Gothani Ghat</td>
<td>33.85</td>
</tr>
<tr>
<td>24</td>
<td>224</td>
<td>Prayagraj, UP</td>
<td>Triveni Sangam</td>
<td>33.45</td>
</tr>
<tr>
<td>25</td>
<td>206</td>
<td>Gaziabad, UP</td>
<td>Garhmukteshwar Kaali river</td>
<td>33.80</td>
</tr>
<tr>
<td>26</td>
<td>182</td>
<td>Farukhabad, Kannauj, UP</td>
<td>Mehndi Ghat</td>
<td>33.81</td>
</tr>
<tr>
<td>27</td>
<td>168</td>
<td>Fatehpur, UP</td>
<td>Samopur Khalspur Ghat</td>
<td>33.84</td>
</tr>
<tr>
<td>28</td>
<td>33</td>
<td>Samastipur, Bihar</td>
<td>Patori / Jaunpur</td>
<td>38.33</td>
</tr>
<tr>
<td>29</td>
<td>38</td>
<td>Begusarai, Bihar</td>
<td>Munger Ghat</td>
<td>38.23</td>
</tr>
<tr>
<td>30</td>
<td>161</td>
<td>Prayagraj, UP</td>
<td>Bharatganj Ujjhni Ghat</td>
<td>43.44</td>
</tr>
<tr>
<td>31</td>
<td>212</td>
<td>Raibareilly, UP</td>
<td>Baksar Ghat</td>
<td>27.27</td>
</tr>
</tbody>
</table>
Pollution Mapping: 2021

Findings

• Out of 224 Samples of river water:
  - Heavily Polluted (WQI : <20) – 10 locations
  - Poor Quality (WQI : <50-20) – 31 locations
  - Fair Quality (WQI : <80-50) – 13 locations
  - Good Quality (WQI : <100-80) – 121 locations
  - Excellent Quality (WQI : 100) – 44 locations

• Water quality generally good
• Ghats lack cleanliness
• Poor disposal of garbage

Other Observations

• Tagged 573 Nalas, 56 Cremation Grounds/Ghats, 19 Ghats, 26 Encroachment Areas and 7 places with open defecation.

• Poverty and unemployment prevalent in fishermen community.

• Some industries / villages / towns directly release domestic waste, sewage and chemical effluents into the river.

• Additionally, geo-tagged flora, fauna, historical/mythological sites and places of tourist interest.
Pollution Mapping: 2021

**Recommendations**

- Use drones/RPVs to physically map 100% of streams, nalas, distributaries.
- Set up 24/7 monitoring stations in 10 heavily polluted and 31 poor quality locations by CPCB/SPCB.
- Mobile app and pollution health dashboard to monitor WQI should be available to all stakeholders.
- Improve local accessibility to WQI and water parameters via GIS / Remote sensing maps.
- Ensure enforcement of Environmental Protection Act to prevent sewage and chemical effluents flowing directly into the river (332 sewage and 11 industrial nalas tagged in first year).
- Ensure 100% treatment of effluents from STP/ETP before release.
- Prevent encroachment on the riverbanks and islands.
- Promote sustainable development of organic farming along the riverside without use of chemical fertilizers and pesticides.
- Undertake wilding (plantation) of riverbanks to reduce soil erosion and constant change of river course.
- Use MNREGA and MPLAD funds for treatment of domestic sewage before release into the river by methods such as bioremediation, root zone, etc.
- Set up 24/7 operational and maintenance contracts to ensure cleanliness of Ghats and Water Fronts.
- Install water fountains to increase dissolved oxygen levels in the water bodies next to Ghats and Water Fronts all along the river.
Development of Entropy and Deviation-based Water Quality Index: Case of River Ganga, India

Authors: Mohit Verma, L.Vijay Anand, Vinod K. Bhatt

Department of Civil Engineering
Indian Institute of Technology Ropar
Punjab, India
&
Atulya Ganga Trust, Gurugram
Haryana, India

13-October-2022
Mobile application for data collection

Water Sampling and critical point identification APP

ENTER WATER SAMPLE DATA
CRITICAL POLLUTION POINT
COLLECT A SAMPLE
POSSIBLE TOURIST POINT

Choose appropriate field

Enter Data
Online Pollution Dashboard

Water Quality Surveillance Dashboard

From Date: 01-01-2020
To Date: 31-03-2020
States: All
District: All
Town: All

No. Of Samples Taken And Tested On Site: 224
No Of Samples Taken For Further Testing: 2
Sites Declared Critical: 639
No. Of Tourist Points: 885

Critical Point Report

Sr No State District Town Type of Pollution Remarks Latitude Longitude Altitude Location Date of Sample Collection
1 Uttar Pradesh Allahabad Allahabad CREMATION GROUND CHHATNAG GHAT 25.41994300 81.89259200 0000-00-00 Unnamed Road, Prayagraj Prayagraj, Uttar Pradesh 20-12-16
2 Uttar Pradesh Allahabad Allahabad GHAT 15 feet from bank 25.30234090 82.65054860 0000-00-00 " Chaupar " Allahabad Prayagraj Uttar Pradesh-212307, IN 20-11-16
3 Uttar Pradesh Allahabad Hardia SEASONAL NATAL 25.77366960 82.09739180 0000-00-00 " Unnamed Road, Prayagraj Prayagraj, Uttar Pradesh-212307, IN 20-12-17

Sample Collected and Tested Report

Column Filters

Export All Records to Excel

22
Development of $M_{ED}$-WQI*

(i) Selection of the water quality parameters

(ii) Developing sub-indices functions ($S_i$)

(iii) Estimation of relative weights using entropy method

(iv) Multiplicative aggregation of sub-indices to estimate $M_{ED}$-WQI

(v) Implementation of $M_{ED}$-WQI in visual basic based spreadsheet program

*Source - Verma et al., Development of entropy and deviation-based water quality index: Case of river Ganga, India, Ecological Indicators, 143:109319, 2022.
Framework of $M_{ED}$-WQI

- **Parametric Deviation**  
  \[ D_i = |D_p - D_d| \]  
  Where $D_i$ deviation in parameter, $D_p$ is parameter value, $D_d$ is MCL.

- **Sub-index calculation**  
  \[ S_i = mD_p + c \]  
  Where $m$ and $c$ constant depends on deviation range.

- **Entropy based relative weights**
  \[
  \begin{align*}
  X &= \begin{pmatrix}
    x_{11} & x_{12} & \cdots & x_{1n} \\
    x_{21} & x_{22} & \cdots & x_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    x_{m1} & x_{m2} & \cdots & x_{mn}
  \end{pmatrix},
  \quad
  Y &= \begin{pmatrix}
    y_{11} & y_{12} & \cdots & y_{1n} \\
    y_{21} & y_{22} & \cdots & y_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    y_{m1} & y_{m2} & \cdots & y_{mn}
  \end{pmatrix}
  \end{align*}
\]

  \[ y_{ij} = \frac{x_{ij} - (x_{ij})_{min}}{(x_{ij})_{max} - (x_{ij})_{min}} \]

  \[ e_j = -K \sum_{i=1}^{m} P_{ij} \ln P_{ij} \]

  \[ w_j = \frac{1 - e_j}{\sum_{j=1}^{n} 1 - e_j} \]

  Where $X$ is eigenvalue matrix, $Y$ is normalized matrix, $P_{ij}$ is parameter index and $e_j$ is information entropy, $w_j$ is entropy weight.

- **Multiplicative aggregation**

  \[ M_{ED} - WQI = \prod_{i=1}^{n} S_i^{w_i} \]

  Where $S_i$ is the sub-index value, $w_i$ is the relative weight and $n$ is number of parameters.
Comparison of $M_{ED}$-WQI with CWQI for Synthetic Data-Set

<table>
<thead>
<tr>
<th>S No</th>
<th>Dataset</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First 15 samples</td>
<td>All water quality parameter within MCL</td>
</tr>
<tr>
<td>2</td>
<td>Middle 30 samples</td>
<td>Water quality parameter having moderate exceedance in MCL</td>
</tr>
<tr>
<td>3</td>
<td>Last 15 samples</td>
<td>All water quality parameter having high exceedance in MCL</td>
</tr>
</tbody>
</table>
Comparison of $M_{ED}$-WQI with CWQI for Ganga Data-Set

Legend
Shape of symbols represent the type of anthropogenic activity in the vicinity (Excellent Class)
- Ghats
- Sewerage Waste
- Seasonal Nallah
- Encroachment
- Cremation Ground
Colour of the symbol represent the water quality status as per $M_{ED}$-WQI (Ghats activity)
- Excellent
- Good
- Fair
- Poor
- Heavily-polluted

Legend
Shape of symbols represent the type of anthropogenic activity in the vicinity (Good Class)
- Ghats
- Sewerage Waste
- Seasonal Nallah
- Encroachment
- Cremation Ground
Colours of symbols represent the water quality status as per CWQI (Ghats activity)
- Good
- Fair
- Poor
- Heavily-polluted
Summary

- The role of mobile application and online dashboard in data collection saves time and human effort. It provides easy accessibility to all stakeholders.

- The $M_{ED}$-WQI approach used in this study captures the pollution level better than existing methods.

- The $M_{ED}$-WQI captures pollution in heavily-populated areas and shows strong correlation of water quality class with anthropogenic activity.
Atulya Ganga Project: Road Map

Upcoming Activities
1. Water Sample Testing and Pollution Mapping – Nov 2022
2. Cyclothon of 2,800 km from Prayagraj to Yamunotri – Feb/Mar 2023
3. Plantation along River Ganga starting with Prayagraj and Mirzapur – 2023
4. Awareness Camps in towns, educational institutions and NCC along River Ganga – 2023

Way Ahead (Contingent on Fund Availability)
1. Preparation and release of Mobile App, 24x7 Online Dashboard to All Stakeholders.
2. Procurement of Drones/RPVs for tagging of nalas and streams.
3. Lab-testing of water samples in IITs / NABL authorized labs for various parameters – BOD, COD, Alkalinity, heavy metals, fertilizers, pesticides, etc.
4. Large scale wilding (plantation) along the entire River Ganga.
5. Organize youth programs at regular intervals to raise awareness.
6. Conduct study on emerging contaminants i.e. micro-plastic.
Atulya Ganga Project: Support the Cause

What We Need

Due to COVID restriction and non availability of sufficient funds – we used basic water testing field kits, and tests were restricted to minimum parameters as per international protocols.

Going forward, to achieve our overall goals, we need to systematically plan and fund our bear minimum needs as follows:

Financial support

• App Development - Hardware & software cost : ₹ 55 Lacs ($ 0.66 M)
• Sample collection, Data collation and Testing : ₹ 50 Lacs ($ 0.60 M)
• App / Website / GIS Integration : ₹ 50 Lacs ($ 0.60 M)
• Office / Organisational / Logistic expenses : ₹ 75 Lacs ($ 0.90 M)
• Miscellaneous expenses : ₹ 25 Lacs ($ 0.30 M)

Annual Recurring Expenses

• Per Year : ₹ 2.55 Crores ($ 3.06 M)
• For 5 Years : ₹ 12.75 Crores ($ 15.30 M)
Q & A
Appendix
Atulya Ganga Trust is a 12AA & 80G exempted entity that entitles you to a tax saving on 50% of your donations. Please contact us for your Tax Exemption Certificate on mike@atulyaganga.com

**Online Donation Bank details**
Account Number – **50200047484009**
Name – **ATULYA GANGA TRUST**
IFSC – **HDFC0009285**

In case of any query, contact on below:
• Email ID: hem@atulyaganga.com
• Contact no. : +91-91677 58456

Web-site : [https://www.atulyaganga.com/support-now/](https://www.atulyaganga.com/support-now/)
Water quality parameters and sub-indices functions details

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(Units)</th>
<th>MCL IS2296/USEPA*</th>
<th>Sub-Indices scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[100,60]</td>
<td>[60,35]</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td>(mg/L)</td>
<td>300</td>
<td>[0,75]</td>
</tr>
<tr>
<td>Chloride</td>
<td>(mg/L)</td>
<td>250</td>
<td>[0,150]</td>
</tr>
<tr>
<td>Fluoride</td>
<td>(mg/L)</td>
<td>1.5</td>
<td>[0,0.3]</td>
</tr>
<tr>
<td>DO</td>
<td>(mg/L)</td>
<td>6.0</td>
<td>[0,0.8]</td>
</tr>
<tr>
<td>TDS</td>
<td>(mg/L)</td>
<td>500</td>
<td>[0,600]</td>
</tr>
<tr>
<td>Turbidity</td>
<td>(NTU)</td>
<td>10*</td>
<td>[0,10]</td>
</tr>
</tbody>
</table>

Note: $S_i$ value will be 100 when parameter value is within MCL

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>$S_i$ Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[100,60]</td>
<td>[60,35]</td>
</tr>
<tr>
<td>pH (≤ 6.5)</td>
<td>y=200x+1200</td>
<td>y=83.33x+465</td>
</tr>
<tr>
<td>pH (&gt; 8.5)</td>
<td>y=-200x+1800</td>
<td>y=-83.33x+785</td>
</tr>
<tr>
<td>Hardness</td>
<td>mg/L</td>
<td>y=0.53x+250</td>
</tr>
<tr>
<td>Chlorides</td>
<td>mg/L</td>
<td>y=-0.267x+167.67</td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/L</td>
<td>y=-133.33x+300</td>
</tr>
<tr>
<td>DO</td>
<td>mg/L</td>
<td>y=50x-200</td>
</tr>
<tr>
<td>TDS</td>
<td>mg/L</td>
<td>y=-0.066x+133.33</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>y=-4x+140</td>
</tr>
</tbody>
</table>

Note: $S_i$ value will be 100 when parameter value is within MCL
Sub-indices functions details
Sub-indices functions details

Graphs showing the relationship between various indices and their scores:
1. Fluoride (mg/L) vs. Indices Score
2. TDS (mg/L) vs. Indices Score
3. DO (mg/L) vs. Indices Score
4. Turbidity (NTU) vs. Indices Score
## Synthetic dataset characteristics

<table>
<thead>
<tr>
<th>S No</th>
<th>Dataset</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First 15 samples</td>
<td>All water quality parameter within MCL</td>
</tr>
<tr>
<td>2</td>
<td>Middle 30 samples</td>
<td>Water quality parameter having moderate exceedance in MCL</td>
</tr>
<tr>
<td>3</td>
<td>Last 15 samples</td>
<td>All water quality parameter having high exceedance in MCL</td>
</tr>
</tbody>
</table>
Visual basic program for calculations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter values</th>
<th>Sub-index, Si</th>
<th>Weight, Wi</th>
<th>Si * Wi</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (0 to 14)</td>
<td>8.5</td>
<td>100</td>
<td>0.0009385</td>
<td>0.03985</td>
</tr>
<tr>
<td>Turbidity</td>
<td>15</td>
<td>80</td>
<td>0.361549</td>
<td>28.9239</td>
</tr>
<tr>
<td>Hardness</td>
<td>305</td>
<td>98.35</td>
<td>0.0455394</td>
<td>4.4788</td>
</tr>
<tr>
<td>Chloride, mg/L</td>
<td>20</td>
<td>100</td>
<td>0.3845185</td>
<td>38.4519</td>
</tr>
<tr>
<td>Fluoride</td>
<td>1.2</td>
<td>100</td>
<td>0.0612979</td>
<td>6.12979</td>
</tr>
<tr>
<td>DO</td>
<td>18</td>
<td>100</td>
<td>0.0091429</td>
<td>0.91429</td>
</tr>
<tr>
<td>TDS</td>
<td>100</td>
<td>100</td>
<td>0.1375538</td>
<td>13.7554</td>
</tr>
</tbody>
</table>

\[ \text{sum} = 1 \]

**WATER QUALITY INDEX**

**SAMPLING LOCATION - Ganga**

MWQI: 92.694

WATER IS OF GOOD QUALITY AND IT IS ACCEPTABLE

<table>
<thead>
<tr>
<th>Class</th>
<th>MWQI</th>
<th>Water status</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>100</td>
<td>Excellent</td>
</tr>
<tr>
<td>II</td>
<td>100-80</td>
<td>Good</td>
</tr>
<tr>
<td>III</td>
<td>80-50</td>
<td>Fair</td>
</tr>
<tr>
<td>IV</td>
<td>50-20</td>
<td>Poor</td>
</tr>
<tr>
<td>V</td>
<td>20-0</td>
<td>Heavily Polluted</td>
</tr>
</tbody>
</table>