**Umang**

**Internet of Things for Water Quality Monitoring and Assessment: A Comprehensive Review**

Indices used in water quality.

**1.** **Chemical oxygen demand (COD):** This is the equivalent amount of oxygen consumed (measured in mg/l) in the chemical oxidation of all organic and oxidisable inorganic matter contained in a water sample.

**2.** **Biochemical oxygen demand (BOD):** This is the oxygen requirement of all the organic content in water during the stabilisation of organic matter usually over a 3 or 5 day.

**3.** **pH**: This is the measure of the acidity or alkalinity of water. It is neutral (at 7) for clean water and ranges from 1 to 14.

**4.** **Dissolved oxygen (DO):** This is the amount of oxygen dissolved in a water sample (measured in mg/l).

**5.** **Turbidity:** This is the scattering of light in water caused by the presence of suspended solids. It can also be referred to as the extent of cloudiness in water measured in nephelometric turbidity units (NTU).

**6.** **Electrical conductivity (EC):** This is the amount of electricity that can flow through water (measured in Siemens), and it is used to determine the extent of soluble salts in the water. 248 J. O. Ighalo et al.

**7.** **Temperature:** The is the degree of hotness or coldness of the water and usually measured in degrees Celsius (°C) or Kelvin (K).

**8.** **Oxidation-reduction potential (ORP):** This is the potential required to transfer electrons from the oxidant to the reductant, and it is used as a qualitative measure of the state of oxidation in water.

**9.** **Salinity:** This is the salt content of the water (measured in parts per million).

**10.** **Total Nitrogen (TN):** This is the total amount of nitrogen in the water (in mg/l) and is a measure of its potential to sustain and eutrophication or algal bloom.

**11.** **Total phosphorus (TP):** This is the total amount of phosphorus in the water (in mg/l) and is a measure of its potential to sustain and eutrophication or algal bloom.

Analysis of specific studies:

|  |  |  |  |
| --- | --- | --- | --- |
| Place/Name | Monitored | Tech used | Misc |
| Wang et al, Xinglin Bay in Xiamen, China. |  |  | Their system was divided into three subsystems-  Data acquisition Digital data  Data processing |
| Shafi et al. investigated the of surface water across 11 locations in Pakistan, | pH, turbidity and temperature | The algorithms considered were Support Vector Machine (SVM), k Nearest Neighbour (kNN), single-layer neural network and deep neural network. | It was observed from the learning process on the 667 lines of data that deep neural network had the highest accuracy (at about 93%). The model could accurately predict water quality in the future six months. |
| Saravanan et al , Tamilnadu, India | monitored the turbidity, temperature and colour | technology was usable in real-time and employed a GSM module for wireless data transfer. | Using a Supervisory Control and Data Acquisition Internet of Things for Water Quality Monitoring … 253 (SCADA) system that is enabled by IoT. |
| Liu et al., pumping station along the Yangtze river in Yangzhou, China. | Temperature, pH, DO, Conductivity, Turbidity, COD and NH3 | IoT enabled but incorporated a Long Short-Term Memory (LSTM) deep learning neural network. |  |
| Zin et al. Curtin Lake, northern Sarawak in the Borneo island. | pH, turbidity, temperature, water level and carbon dioxide | wireless sensor network enabled by IoT  system consisted of Zigbee wireless communication, protocol, Field Programmable Gate Array (FPGA) and a personal computer. |  |

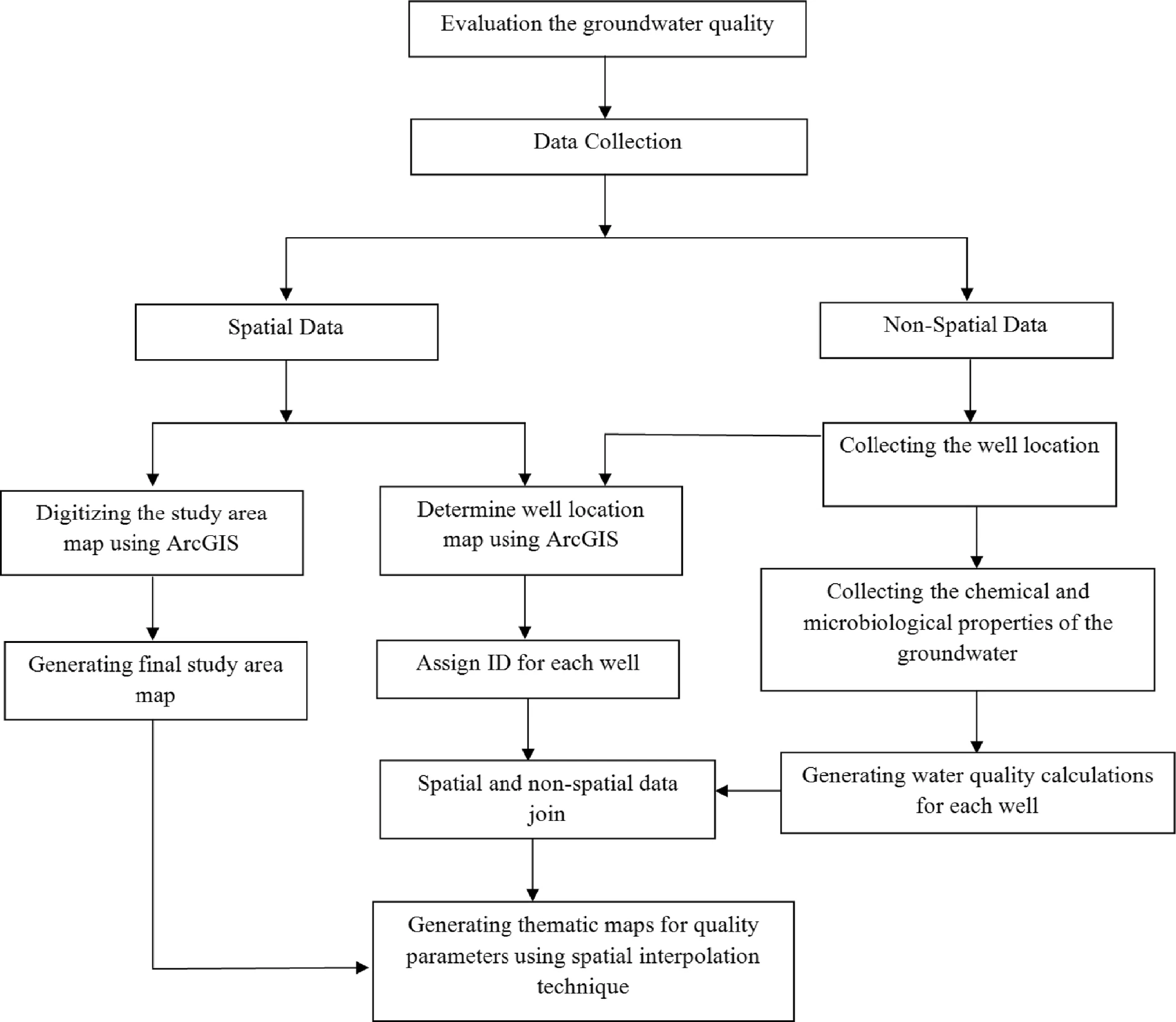
**ENVIRONMENTAL MONITORING AND ASSESSMENT**

**JOURNAL 193-2**

GIS-based assessment of groundwater quality for drinking and irrigation purposes in central Iraq

([GIS-based assessment of groundwater quality for drinking and irrigation purposes in central Iraq | SpringerLink](https://link.springer.com/article/10.1007/s10661-021-08858-w))

The analysed water quality parameters were used as an attribute database to produce thematic maps using a geographical information system (GIS) environment. In this paper, the water quality index (WQI) and the irrigation water quality index (IWQI) were calculated for different groundwater samples using various parameters including the Electrical Conductivity (EC), Cl−, HCO3−, Na+ and pH. Moreover, the groundwater suitability for irrigation purposes has been assessed using indices such as Kelly’s ratio (KR), sodium absorption ratio (SAR), residual sodium carbonate (RSC), soluble sodium percentage (SSP) and permeability index (PI). Water quality index maps have been developed using the GIS environment.

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# Weights used as per Meireles et al., [2010](https://link.springer.com/article/10.1007/s10661-021-08858-w#ref-CR26)

| **Parameter** | **Weight (wi)** |
| --- | --- |
| EC | 0.211 |
| Na+ | 0.204 |
| HCO−3 | 0.202 |
| Cl− | 0.194 |
| SAR | 0.189 |
| Total | 1.0 |

**@Prakhar**

**Fluidsens**

**SWA1 – Smart Water Analyzer, a highly sensitive, affordable spectrum sensor for continuous online monitoring and rapid detection of microbial contamination in water.**

The water from the water source pipe is passed into the SWA-1 sensor, and flows through the sensor’s inner channel. Two LED sources are installed at one end of the channel and emit light at various wavelengths, 260-300 nm and 750-900 nm respectively. A special sensitive receiver is installed at the opposite end of the channel. Emitted light beams pass through the water medium in the channel and encounter particles of various origin. As a result, light energy is absorbed by the particles, and the receiver identifies reduction in the energy power, as compared to that measured when the “baseline” water quality reference was established (which may be referred to as a “reference light energy” level).

to obtain reliable data on the microbial contamination load in water, an additional LED source is used in the sensor’s channel that emits light at wavelengths in the range of 750-900 nm. Under such radiation wavelengths, light energy is absorbed by particles of non-biological origin. SWA-1 compares measurement results at various light wavelength ranges, and if certain ratios between signal strength levels at various UV and IR wavelengths are reached, the sensor provides an indication whether the contamination is microbiological or general.

The SWA1 sensor sensitivity starts at 10 bacteria in 1 milliliter of source water. Such high sensitivity is attained by a proprietary algorithm of the water source irradiation by light sources. The unique light radiation algorithm and self-cleaning ability  constitute the principal IP claimed in Fluidsens patent applications.

**VWM Solutions**

**ColiMinder technology is based on direct measurement of specific metabolic (enzymatic) activity of target organisms present in the sample. The enzymatic approach directly measures the specific enzymatic activity present in the sample. The measured enzymatic activity per sample volume is used as a measure of the contamination.**

The enzymatic measurement approach is the only rapid measurement approach that allows:

->Technology independent determination if contamination limits

->Calibration of devices independent of their measurement technology

The enzymatic approach evaluates the level of contamination by measuring a signal from all target organisms in the sample volume. This approach requires no sample pre-treatment and less sophisticated technology and is therefore more robust than approaches evaluating individual organisms.

There are enzymes that are specific to certain organisms or groups of organisms. This offers the possibility to specifically measure the metabolic activity of the respective target organisms.The most basic indication of a viable organism is its metabolism, since it reflects the energy that the cell takes from the environment. This metabolism takes place through enzymes.The metric is the enzymatic activity per volume of a specific enzyme. It reflects the energetic turnover of the target organisms per volume or in other words the concentration of living target organisms, which represents the degree of contamination.

KEY FEATURES:

->fully automated sampling, measurement, cleaning and calibration

->Online data visualization and automatic notification

->1000 measurements without staff intervention

->up to 54 (80 in special cases) measurements per day

->Fully controllable through internet connection

->2 sample intakes (more optional)

DATA TRANSFER AND VISUALIZATION:

->Measurements data is directly transmitted to server through internet/ network connection

->Live data visualization on dedicated website, results can be downloaded

->Automatic notifications can be set (E-mail, SMS)

->Measurement results are also available through RS232/RS485 or Modbus TCP (optional)

->Measurement results can be saved on USB Flash Drive directly from the device

->4 to 20 mA output optional

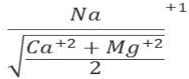
**Suryansh**

**Emergence of Startups in Production of Water Monitoring Nanosensors**

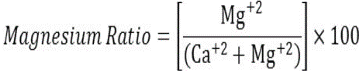
* Water monitoring nanosensors have an increasing market to the extent that these nanosensors have a share of about 30% from the whole nanosensors market.
* production of nanosensors to monitor pH value, amount of oxygen in water, microbial pollution, nitrate and phosphate ions, amount of pesticides in water, and nanosensors to determine the amount of water hardness.
* a sensor by using carbon [nanotubes](https://statnano.com/nanomaterial/4) to detect water leakage in transferring pipelines
* [NanoAffix Science LLC](http://www.nanoaffix.com/) develpoed technology to produce a sensor to constantly monitor water pollution. Detects bacteria, nitrate, phosphate, and heavy metals, [**Graphene**](https://statnano.com/nanomaterial/21) nanosheets.
* In general, water monitoring nanosensors are very attractive for companies to invest, and they have a very bright future in markets.

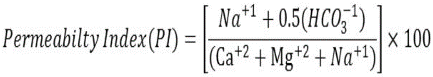
**Hydro-Chemical and Physico-Chemical Monitoring of Groundwater**

* The type of water that predominates in the study area is Ca-Mg-HCO3type, based on hydro-chemical analysis.
* The objective of the present work is to monitor the major ions present in underground water and to evaluate the ground water quality in north-west region of Punjab, India.
* In this case study the methods proposed by Back[10]  and Hanshaw, Wilcox, Eaton, Todd [10] and USSL (US Salinity Laboratory) classification have been used. Moreover other parameter such as TDS, pH, DO etc have also been studied for checking suitability for drinking.
* **Cations like calcium and magnesium were analyzed** using volumetric method while sodium and potassium were analyzed by flame photometer, **whereas anions like chloride and bicarbonate** were analyzed by volumetric method while sulphate was analyzed by spectrometric method.
* **The onsite analysis of various physicochemical parameters** (such as pH, TDS, DO, Electrical conductance and salinity) was carried out using water analysis kit.
* **The analysis of heavy metal** was carried out by emission spectrometer, ICAP 6300
* **Finally,**
* The suitability of water for irrigation is determined based on SAR, %Na, RSC and salinity hazard, it is only an empirical conclusion
* Other factors like soil type, type of crop, frequency and pattern of crop, rain fall and its frequency, climate, etc. all are important in deciding the suitability of water
* Most of the samples in the study area fall in the suitable range for irrigation purpose either from SAR, % Na or RSC values.Physicochemical characteristic of water were determined in order to assess the overall quality of water.
* The concentrations of heavy metal ions in water samples were well below the permissible limits indicating their suitability for drinking and irrigation purposes
* Most of the samples in study area fall in the suitable range for irrigation and drinking purpose as recommended by WHO 2011

 (SAR) (SAR<10), good (10-20), doubtful (20-30) and unsuitable (>30)

 (RSC<1.25), marginal (RSC=1.25-2.50) and unsuitable (RSC>2.50)

 good (Mg ratio<20), suitable (Mg ratio=20-50) and poisonous (Mg ratio>50)

  good (Mg ratio<20), suitable (Mg ratio=20-50) and poisonous (Mg ratio>50)