Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 45 No. 01 (2024)

IoT for Managing Ground Water

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ABSTRACT: Internet of Things (IoT) connected devices and devices placed strategically throughout ground water locations is the backbone of this breakthrough. Among the many pieces of information gathered by these sensors are readings of the surrounding environment, including things like air quality, soil moisture, humidity, and temperature. By continuously collecting this attributed data, we can not only assess the groundwater situation in real-time, but we can also analyze trends and use predictive modelling to plan for future resource management.

Keywords: *web applications, tools, monitoring and mobile devices.*

INTRODUCTION

Planning, assigning, and monitoring water resources and associated equipment, such as pipelines and pumps, An IoT-based water management system is one that makes use of IoT hardware and software. Devices like as sensors, controllers, and meters are integrated with web applications, data processing and analysis tools, and mobile devices to form water management systems that the IoT produces. It establishes stage for effective management of water supplies, monitoring of freshwater quality, identification of pollution, and other related tasks.

What is the operation of an intelligent water management system? Connected sensors and gadgets embedded in the pipes and pumps measure the water's temperature, level, flow rate, and other parameters in real time. After that, they upload the data to a server in the cloud so it can be processed and analyzed further. The findings help with equipment maintenance and water resource management. Businesses, governments, and consumers all benefit from smart managing water resources with the use of IoT. It sheds light on water resources and related machinery, which improves efficiency and sustainability.

A multitude of sensors are used by internet-connected smart water management systems to collect real-time data on resource utilisation. Through these gadgets, the user's internet application receives the data. With this data, we can better analyse usage trends and perhaps use water more wisely. Numerous pieces of gear and equipment used in the water sector need regular servicing. Companies can automate and constantly monitor their assets— including storage tanks, pipelines, pumps, and treatment plants— Under the framework of the IoT, which allows them to decrease maintenance costs.

The Internet of Things (IoT) will provide transparency to the water delivery system by collecting data in real-time. By making that data accessible to all parties involved, we can reduce the likelihood of miscommunication, boost efficiency, and make more informed business choices. Linking the water supply chain with industrial IoT monitoring systems enables stakeholders to remotely operate their equipment and networks. The 2Smart Cloud platform, in conjunction with WebbyLab's 2Smart Standalone, allows for remote water system monitoring. Businesses may automate a lot of processes that used to need human involvement with using the use of IoT-based water management systems.

Depending on the sector, automated operations might range from providing water on demand to charging customers differently depending on their water use. Water management systems that make use of Internet of Things (IoT) devices are able to gather and analyze data, letting companies anticipate problems and react immediately. They may monitor water quality and detect pollution before it becomes dangerous, for instance, by using IoT technologies.

LITERATURE REVIEW

Zhou, Qingguo et.al. (2018). In dry inland river basins, groundwater is essential, and managing important for the well-being of the local economy and ecosystem. The standard methods of sustainable management include making assumptions and then analysing potential outcomes or building optimization models to find the best course of action via simulation. But because of outside influences, the groundwater system is dynamic throughout time. Groundwater management that relies on static data is therefore somewhat out of date. In order to investigate long-term plans for groundwater supplies, three distinct limitations on groundwater levels were given. According to the findings, the simulation-optimization model could find the best pumping yields while still meeting all of the requirements. The second step was to include wireless sensor network (WSN) technology into the simulation-optimization model so that management could access real-time characteristics. Groundwater management's time-varying feature might update on-the-fly observations, limitations, and decision factors, according to the findings. To further streamline the decision-making process, a web-based interface was also established. This research aimed to improve choices about the administration of a sustainable by combining a simulation and optimization model with WSN approaches. At the same time, it sought so that the valuable groundwater resource may be monitored and managed in real-time.

Shaohong, Mo. (2015). An essential and fundamental part of managing water resources is keeping tabs on data about water resources online. In this research, we propose an IoT-based integrated system for water resource monitoring and management. Data application, information transfer, and equipment perception are the three main layers that make up the system. A network of sensors is built to track data about water in the equipment perception layer. Transmitting data in real time is accomplished at the information transmission layer. Users are able to store, manage, apply, and exchange water information online using the data application layer. The reliability of the data provided by our technology in real time on water resources for management purposes is shown by its application.

Dandge, Kailas et.al. (2022). One of the most ubiquitous and fundamental elements for life support is water. Groundwater is a very useful resource that humans may get many benefits from. However, groundwater has been found to have high levels of pollution due to toxic elements released by industries, landfills, and non-point sources like pesticides and fertilizer. This makes it important that evaluate the purity of the water for both current use and future development as a sustainable human water source. Groundwater is a major water supply for rural areas in India. Residents of the Bhokardan region of Jalna District are dealing with a number of water quality difficulties when it comes to drinking water, thus the quality of the groundwater there is very important. Groundwater is also a major source of household supplies. The values were calculated at thirty-five diverse sites to create a water quality index. The research area's spatial distribution map shows that, before the monsoon, every region has "Poor water" or "Very poor water" water. However, After the monsoon, the water quality at most places in the north and south of the area improves, but at others it drops from extremely low to poor. A few of locations in the area's northern sections fall into the "Good water" category, but that's about all. Results from the present study's water quality index analysis showed that groundwater tests showed heightened turbidity and E. coli levels, which led to high "Water Quality Index" (WQI) values. In the months leading up to and after the monsoon, hardly a single spot meets the standard for high-quality water.

Wu, Guangwei et.al. (2022). With the fast development of Web technology, WebGIS technology has been continuously enhanced, allowing for more powerful and complex functionalities. As a result of its platform independence and service dependability qualities, WebGIS is available to more people. Its functions and applications are also constantly being improved, allowing for more diversified, sophisticated, and adaptable applications to be produced from interactions with Web information services. Applying WebGIS technology to groundwater information management allows for the system's criteria to be satisfied. Using ArcGIS Server's geographic processing service, we were able to accomplish two sophisticated spatial analysis tasks: assessing the sensitivity of groundwater and doing an isoline analysis of groundwater levels. It offers a visual and user-friendly way to analyse groundwater spatial data and a practical way to apply spatial analysis widely. Additionally, I was able to see the most recent groundwater data displayed and pinpoint the exact position of the groundwater monitoring station. Solving complex problems like assessing, warning, and managing groundwater overexploitation areas, as well as discovering new ways for dynamically supervising, warning, and managing local groundwater, the system uses location-based data for use in analysis, modeling, and research. A distributed system architecture underpins it, and it is built on Internet technological standards.

IOT SOLUTIONS IN WATER MANAGEMENT SYSTEMS

Numerous fields might benefit from IoT-based water management technologies. Consider which ones are most crucial.

Smart Irrigation

Connected devices allow for watering whenever needed. Using data gathered from sensors that measure soil moisture and temperature as well as weather predictions, the watering schedule, and other factors, they propose an optimal irrigation plan. For optimal plant health and harvests, use the smart irrigation capabilities supported by our 2Smart Standalone platform.

Water System Integrity

Additional possibilities for smart water management, such as IoT-enabled sensors to track asset deterioration, are available. They are useful for preventing water leaks. A water leak and temperature sensor, the Strips Drip by Sensitive is only one of several similar products available.

Smart Water Monitoring

All of the aforementioned aspects of water system integrity and irrigation are a part of smart water monitoring systems. Also included are telemetry devices, instruments for tracking rainfall, sensors to determine water quality, and so on. The ability to monitor water levels and make informed decisions using that data is made possible by all of this. An example of such a system is our 2Smart Standalone solution. Its design enables the connection of numerous devices that monitor the level of water using any protocol.

Smart Water Management

With the help of the Internet of Things (IoT), an intelligent water management system might be created by integrating various water monitoring sensors and devices with robust data analytics software. Some examples of these are user dashboards, smart meters, and bespoke automation systems for water management. For instance, using 2Smart Standalone, you may build an endless number of automation scenarios, as smart irrigation, water leak detection, or backing for important water condition requirements.

USE CASES OF SMART WATER MANAGEMENT SYSTEMS USING IOT

Internet of Things (IoT) water management technologies are finding use in a wide range of industries, from farming to city planning. Let's have a look at how these technologies are used in the real world.

Rain and Stormwater Management

Internet of Things (IoT) sensors track the velocity and quality of water as it flows through storm drains and sewage systems. The data obtained may be used to improve drainage systems and make them more resistant to floods in the case of severe rains.

Another option is to implement a stormwater management system, which will assist in controlling the discharge of rainwater and protecting watersheds from contamination. The smart pond technology in Baltimore does just that. In order to control the flow of rainfall, this system makes use of Amazon Web Services (AWS) cloud computing and makes using both past pond data and real-time weather forecasts.

Water Treatment Plants

Water treatment facility operations are made easier by the Internet of Things (IoT). To make sure discharge satisfies regulations, plant operators might use sensors to measure turbidity, pH, and pollutant levels, among other water quality characteristics. Companies such as Veolia provide Internet of Things (IoT) solutions for water treatment.

Flood Management

Devices that measure the depth of water in rivers and drainage systems, and other locations prone to flooding may aid in the detection of floods. Authorities can anticipate and respond quickly to natural catastrophes with the help of ML algorithms that examine meteorological and sensor data from the past. An exemplary case of a flood defence program it effectively utilizes the IoT and other advancements is the Dutch Flood Protection Programme.

Greenhouses and Agriculture

Improving crop cultivation and conserving water resources may be achieved by the planned implementation of watering plants intelligently in agricultural settings or greenhouses, guided by data from soil quality sensors. By monitoring soil and plant nutrient needs in real time, this method also makes timely fertilization easier. Plus, it keeps tabs on the greenhouse's temperature, humidity, and light levels thanks to WebbyLab installed a 2Smart Standalone automation system in a smart greenhouse.

WebbyLab Can Help with IoT-based Smart Water Management Solutions

In 2011, WebbyLab began developing applications and devices for the Internet of Things. Throughout this period, we accomplished quite a bit in the domains of IoT water management systems (2Smart Standalone), HVAC (SmartHeat) solutions, and energy management (MyBox). Thanks to the IoT, we were able to do all of this.

If you have a difficult Internet of Things (IoT) project involving smart water management, our development team can handle it. If our clients want the greatest outcomes, we have to adhere to their specifications.

Evaluating the effects on stream water quality

Groundwater quality

We can see the state of the physical and chemical characteristics when we evaluate the samples using established procedures and formulae. Graphs and bars are used to present the data.

By analysing 30 samples taken in both the upstream and downstream directions of the research region, the physicochemical results show that the lowest pH was found at 6.51 at Kodurpadu and the highest at 7.67 at Gudipallipadu. According to the United Nations agency (UNA), the ideal all of the samples were within the acceptable pH range for drinking water, which is 6.5 to 8.5. Every sample falls within the specified range.

At its lowest point, Mopuru has a hardness value of 91.1, while Alaganipadu has a high of 1234.5. Only 43% of the samples were within the desired range; 17 samples were found to be over 300 ppm. There is a 20% tolerance for the D/S reservoir aspect, however the U/S aspect is outside of the allowed range is within the limitations by 66%.

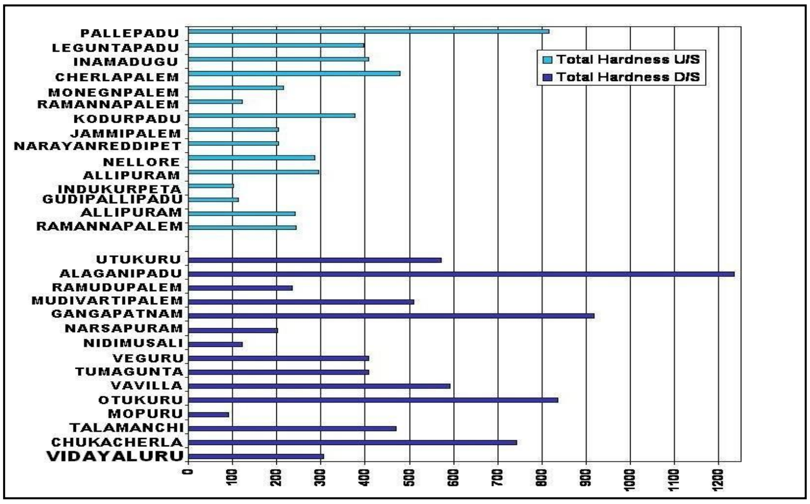

Fig 1. Groundwater sample concentrations for total hardness analysis

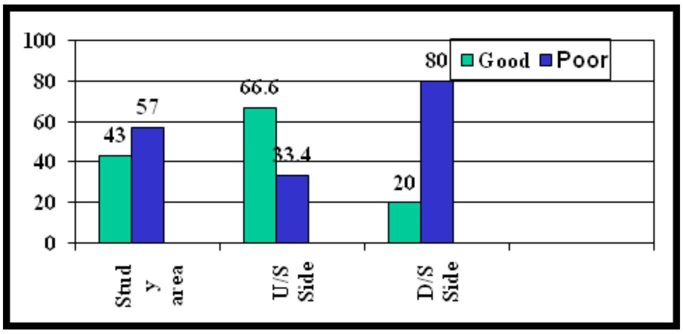

Fig 2. % of Total Hardness in groundwater

Chloride

The chloride value ranges from a low of 18.48 ppm at Gudipallipadu to a high of 603.81 ppm in Ramudupalem. The chloride levels in six of the sample sites are within the acceptable range, and a suitable mode was achieved in 73.3% of the D/S catchment area and 86.6% of the U/S region.

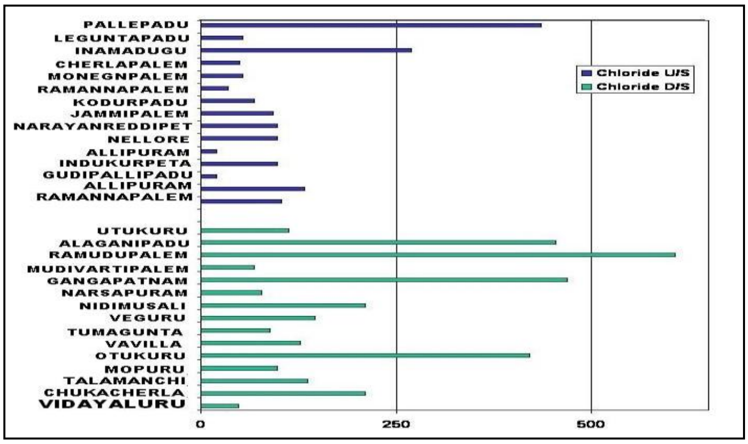

Fig 3. Evaluation of chloride concentrations in source water

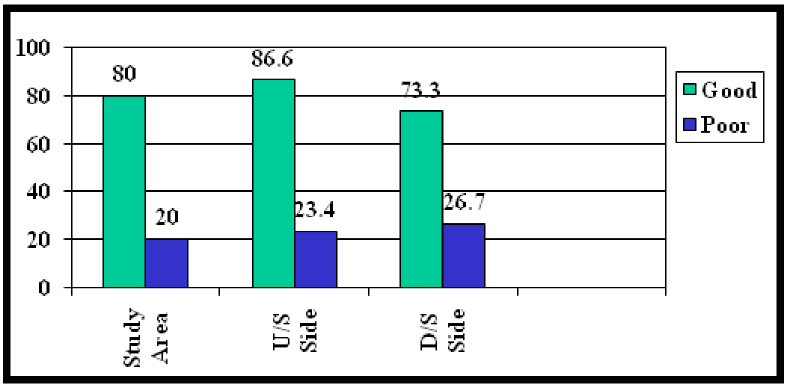

Fig 4. % of ground water samples for chlorides

Jammipalem had the highest Anlkanity value of 702.1 ppm, while Gudipallipadu had the lowest at 157 ppm. There are six samples that fall short of the required minimum.To rephrase, the majority of samples (80%) exceeded the standard thresholds. Comfort zone was reached by 66.6% on the U/S side and 33.3% on the D/S side.

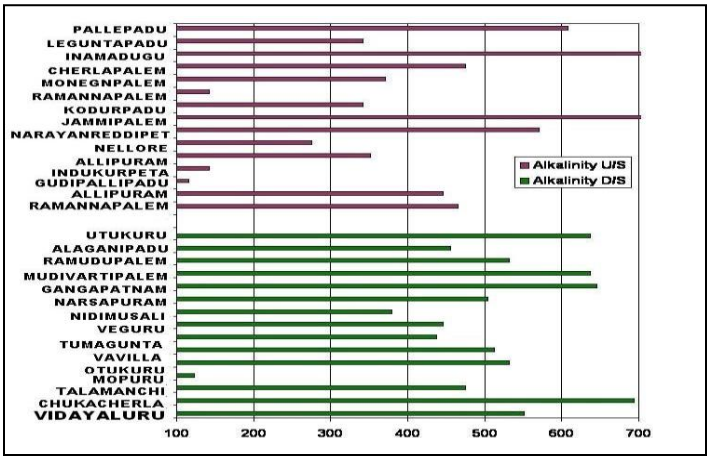

Fig 5 Groundwater pH and alkalinity concentrations

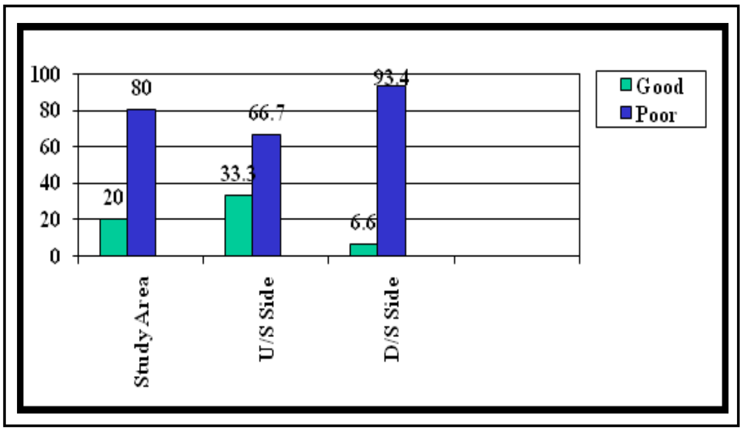

Fig 6. % of groundwater samples for alkalinity

Groundwater nitrate, fluoride, and sulphate concentrations were determined using spectrophotometry, and all three were found to be within the safe ranges set by the World Health Organisation. the nitrate and sulphate U/S levels are lower than the Penna River D/S values.

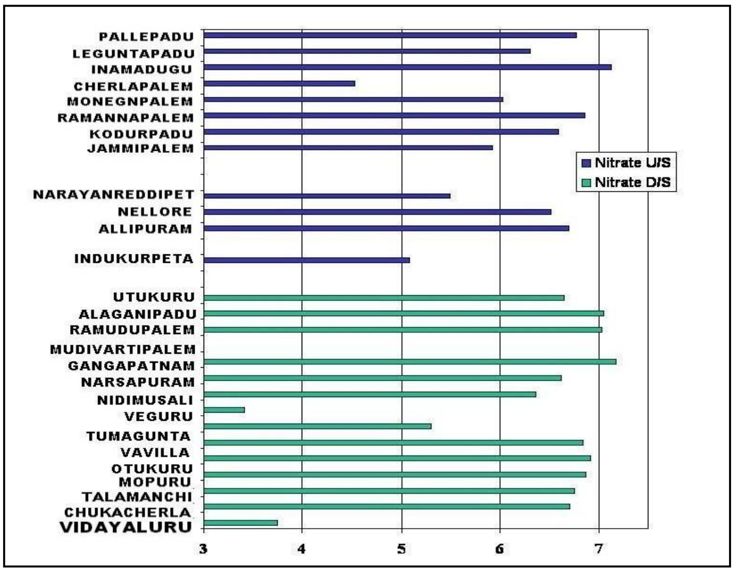

Fig 7. Nitrate concentration in subterranean water

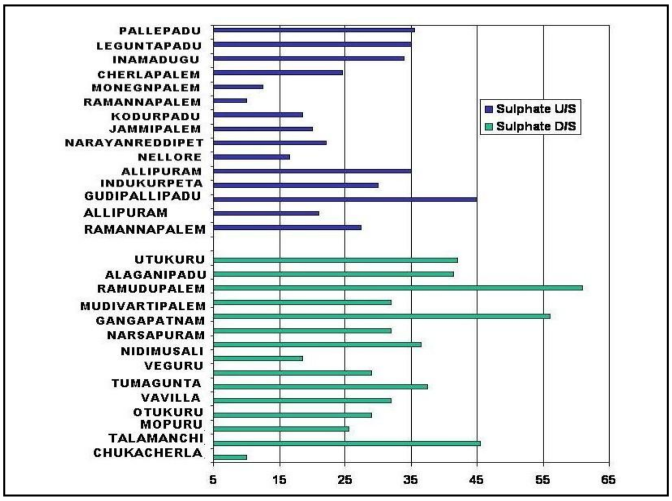

Fig 8. % of sulphates in ground water

The following table was created using all of the aforementioned parameters.

Table 1. Number of high-risk areas inside the research unit

Range of WQI	Categorized	No of villages
0-25	Excellent	3
26-50	Good	11
51-75	Poor	8
76-100	Very Poor	4
>100	Unfit for drinking	4

Inside the research facility, the number of environmental stress zones the standard of groundwater depends on all of these factors. Considering the U/S and D/S region, the effects of groundwater quality at different locations are shown in the table below.

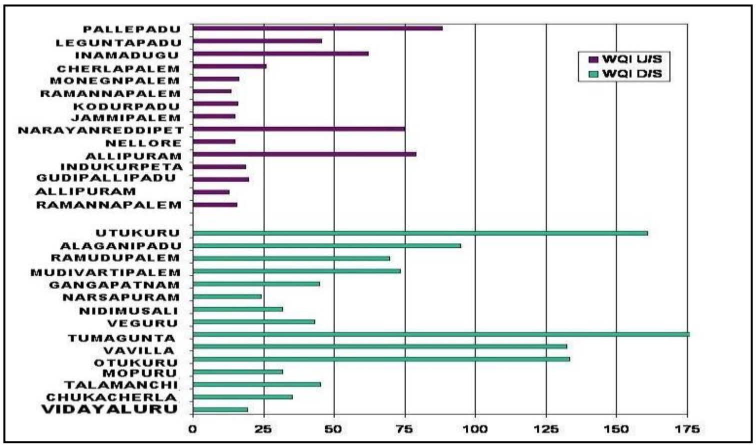

Fig 9. WQI Chart

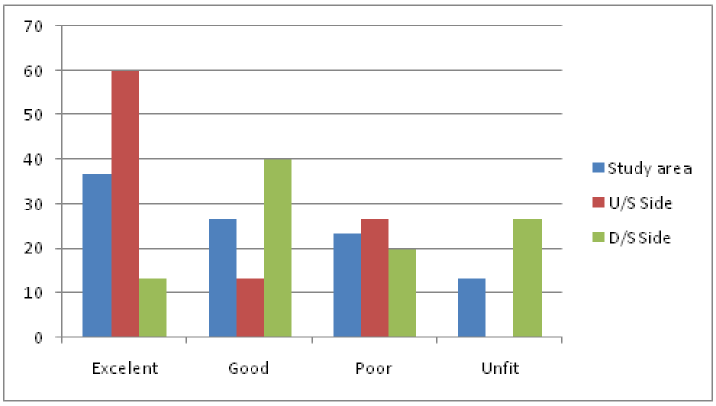

Fig 10. % of WQI selected area

Soil Quality

The capacity of soil to sustainably and productively operate is what we mean when we talk about soil quality. This capacity is related to the soil's effect on the environment, plant and animal life, and human health. A sustainable ecological system relies on high-quality soil and water. Groundwater quality is strongly related to soil quality parameters. Although healthy soil is no guarantee of high-quality water, bad soil may set the stage for situations that worsen water quality. Chemical contamination from overuse of fertilizers and pesticides is often believed to be the root cause of soil pollution, which in turn may contaminate groundwater. Erosion, companion, and salinity are other types of soil pollution, however. the percentage of annual variance in soil characteristics.

Table 2. Annual percentage change in soil parameter values

Villages/Places	Bulk Density	Moisture content	Organic matter	C	pH	EC	Ca	Mg	SO_4	Nitrate	Phosphorus (P)	Potassium (K)
PALLEPADU	2.1	33.2	5.2	5.2	2.4	17.53	21.42	8.8	26.3	8.6	13.63	10.25
LEGUNTAPADU	9.9	49.25	3.19	18.2	4.3	9.4	12.5	15.4	3.66	4.9	15.38	10.97
INAMADUGU	3.9	19.6	8.2	7.9	3.5	21.8	18.3	11.	2.4	24.12	16.6	10.38

						7	9	6				
CHERLAPALEM	15.5	51.2	2.1	2.2	3.3	3.8	3.98	17	4.7	2.3	16.6	10.2
MONEGNPALEM	9.7	23.4	4.4	4.47	2.5	6.6	11.08	14.3	11.01	10.8	21.4	9.16
RAMANNAPALEM	2.1	37.5	5.2	4.9	5.6	10.7	15.1	12.7	11.99	6.03	21.6	9.18
KODURPADU	10.9	15.6	14.8	14.9	3.2	13.9	6.02	21.5	8.6	6.02	25	12.65
JAMMIPALEM	6.07	20.32	8.48	12.1	4.3	35	6.89	6.9	3.8	7.1	25	15.58
NARAYANAREDDIPALEM	2.67	11.5	7.38	18.3	1.9	14.73	5.9	19.9	8.6	4.88	25	16.2
ALLIPURAM	7.7	24.11		15.42	3.1	12.82	10.9	19.2	4.6	4.75	17.85	11.11
INDUKURPETA	3.07	22.11	7.46	24.51	5.1	7.03	5.05	4.89	11.24	6.15	17.39	10.97
GUDIPALLIPADU	2.5	42.7	13.8	13.9	1.3	17.5	20.5	15.2	12.8	5.4	17.85	10.46
UTUKURU	1.9	3.1	2.01	1.96	1	13.8	10.8	11.5	6.8	5.6	16.6	8.1
ALAGANIPADU	2.47	29.9	10.61	10.54	1.01	5.3	12.18	21.6	4.1	10.6	19.44	9.2
RAMUDUPALEM	9.69	41.66	9.72	20.82	4.01	5.7	18.5	4.4	1.72	1.01	17.39	10
MUDIVARTIPALEM	2.7	40.1	12.03	11.9	3.08	6.7	3.98	9.5	5.3	1.8	25	15.58
GANGAPATNAM	5.3	21.4	8.3	8.4	3.8	9.8	11.98	9.1	9.1	9.2	18.75	13.72
NARSAPURAM	13.9	17.17	17.27	17.25	7.4	24.05	17.22	4.4	5.5	6.5	6	15.18
NIDIMUSALI	2.4	32.2	5.49	5.55	1.2	11.6	15.76	18.6	2.5	8.7	29.41	14.58
VEGURU	1.6	12.08	18.2	10.27	2.5	3.01	19.24	22.6	13.19	2.01	27.77	15.31
TUMAGUNTA	4.77	20.4	11.08	11.06	3.9	10.7	9.5	9.6	9.3	8.1	29.6	15.29
OTUKURU	3.1	17.46	11.1	12.8	2.5	17.8	17.46	7.8	8.49	6.02	24.3	15.46
MOPURU	2.7	39.8	7.6	18.3	2.6	8.52	3.1	6.58	5.4	16.16	28.59	15.78
TALAMANCHI	9.2	20.43	11.15	17.45	2.4	32.77	17.22	28.8	4.57	3.8	28.59	15.66

You can see the research area on both sides of the river, as well as the highest and lowest percentages of sample variance, in the table below.

Table 3. Soil parameters statistical values

Parameter	Minimum value & Location		Maxmum value & Location		% of variation in a year & Location	
Bulk density	0.92	Cherlapalem	1.124	Lenguntapadu	1.60%	Pallipadu
Organic matter	0.63	Mudivartipalem	1.295	Alaganipadu	16.25%	Narsapuram
EC	0.2	Ramannapalem	0.243	Jammipalem	35.10%	Gangapatnam
pH	6.5	Ramudupalem	7.87	Cherlapalem	no variations	Narasapuram
Potassium (K)	62	Narayanareddypet	97	Nidimisali	17.80%	Mudivartipalem
phosphorus (P)	12	Kodurpadu	37	Utukuru	29.60%	Talamanchi

Statistical data on environmental stress zones according to SQI are provided in the table below.

Table 4. Number of ecologically sensitive areas determined by (SQI)

S.NO	Range of SQI	Categorized	No of Villages
1	0 to 0.4.	Poor	3
2	0.41 to 0.6	Average	9
3	0.61 to 0.7	Good	10
4	0.71 to1	Very good	2

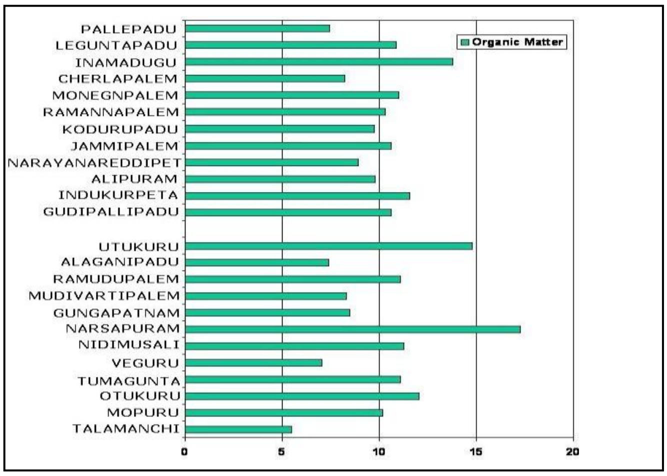

Fig 11. % Changes in Organic Compound Content of Soil Samples

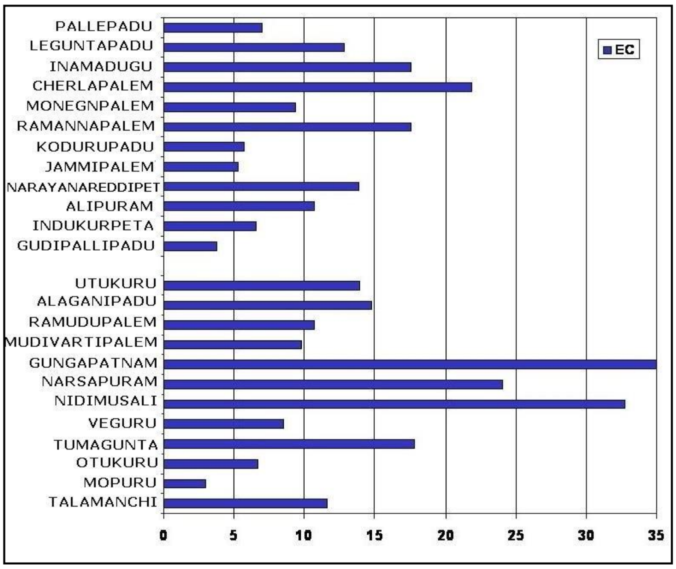

Fig 12. % disparity between soil EC

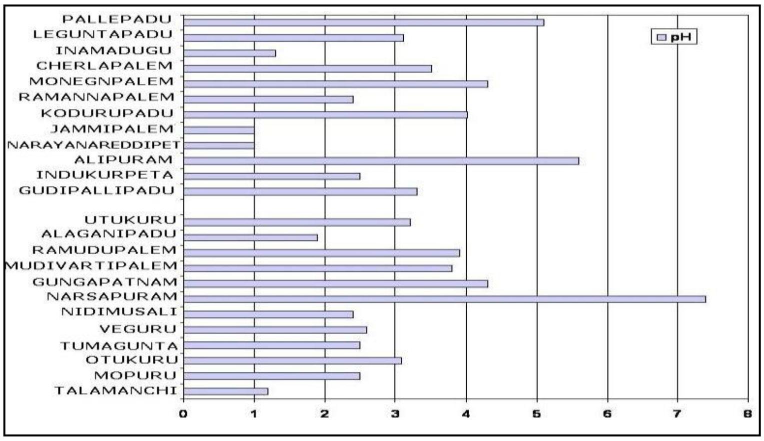

Fig 13. % pH consistency in dirt

CONCLUSION

Agricultural research and extension are anticipated to meet the region's growing need for economic growth. However, such efforts are limited by the characteristics of the local soil, water supply, and morphometry. It would seem that the local farmers are losing money and won't be able to maintain themselves if they stick with the same old ways.

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