Progress Report

Development of Web and Mobile enabled Knowledge Based System for identification water quality of irrigation and suitability of crops
Year Jan 2010-Jan 2012

Introduction: Literature review

Water is vital to life, maintenance of ecological balance, economic development and sustenance of civilization. Planning and management of water resources and its optimal use are a matter of urgency for most countries of the world, and even more so for India with a huge population and increasing demand of food. Even with the large federal investments in pollution control since 1972, the president's council on Environment Quality reports that the nation continued to be damaged by pollution and misuse of water resources. In many arid and semi-arid countries water is becoming an increasingly scarce resource and planners are forced to consider any sources of water that might be used economically and effectively to promote further development.

Agriculture is the primary source of live hood in rural areas, which account for 75% of India's population and 80% of its poor. The rapid expansion of irrigation and drainage infrastructure has been one of India's major achievements. Today, India has moved from the specter and actuality of food imports and periodic famines to self sufficient since the early 1970s. Recently estimated India's irrigation development was at 113.5 M ha.

About 56% of total agricultural production comes from irrigated agriculture, which is approximately 35% of the net sown area. As per World Bank 1998 report, total area under irrigated segment for food crops has increased to 42.9 M Ha in 1992, which was 26.53 M Ha in 1971 where as area under non-irrigated segment for food crops has decreased to 43.01 M Ha, which was 52.38 M Ha in 1971. Irrigation is mainly provided on wheat (84% of the total area sown with wheat is irrigated), rice (47%) and sugar cane (88%). Cotton (33%), pulses (10%) and coarse cereals (10%) are also irrigated to a lesser extent

Furthermore, the spread of irrigation has also enabled crop diversification. Crop yields have increased substantially, and irrigated crops produce much more than rained crops. However, irrigated crop yields in our country are still low relative to yields under irrigation in other countries. This is mainly due to poor water management on the majority of the surface command areas. The potential for irrigation to raise both agricultural productivity and the living standards of the rural poor has long been recognized. Irrigated agriculture occupies approximately 17 percent of the world's total arable land but the production from this land comprises about 34 percent of the world total. In India, net irrigated area is around 53 m ha. In India, poor quality water is used for irrigation in different states and the potential varies significantly.

Irrigation is beneficial only when it is properly managed and controlled. Adequate and reliable knowledge as well as experience about water supply, yield responses, irrigation efficiency etc. is required. When plenty of water is available, farmers are tempted to over-irrigate their lands without being conscious of harmful effected. Impaired soil aeration, imbalance in nutrients uptake restricted root system, toxicity of nutrients, loss of soil fertility, soil erosion, production of harmful gases, water logging are some of the harmful effect of improper irrigation.

One key point in meeting worldwide serious challenges like spiraling demand for food, declining cultivated area due to population pressure, is the adoption of technologies, particularly ICT, by farmers in agricultural production.

The information technology played an important role in information and knowledge dissemination in the last decade. The usage of Artificial Intelligent (AI) technologies like Knowledge based System(KBS) is used to transfer information and knowledge in the almost all the domains including environment, agriculture etc has become necessary. According to Freedman (1995), KBS is *"An automated information application that uses a database of knowledge about a subject"*. The number, complexity and rapid change of information in yield extension require the development of internet, wireless, satellites and mobile based information report system to support yield extension. The widespread availability and use of internet, intranet, and mobiles provide the opportunity to disseminate expertise and knowledge to mass audiences. By implementing KBS as knowledge servers, it becomes economically feasible, profitable, and beneficial to users, to publish expertise on the Net or provide Knowledge through devices like mobiles. KBS on mobiles can supports a large of users who communicate with the system on web, mobile etc. Now-a days is a wireless trend. Intelligent agents is changing the way communication is getting done in the Information Age. The agents act on behalf of their human users to perform information gathering tasks, such as locating and accessing information from various sources, filtering unwanted information, and providing decision support. Thus, the widespread availability and use of internet, intranet, and mobiles provide the opportunity to disseminate expertise and knowledge to mass audiences. In particular, Web and mobile technologies provide a new media for sharing information about decision support and a new means of delivering knowledge decision support capabilities.

•Origin of the research problem

India is the second most populous nation in the world and Asia's most polluted country. As far as water pollution is concerned, it is on second position. This reflects seriousness about future requirement of non-polluted water. This inspires us to carry out this research work.

Further, environment degradation in Gujarat is on second number after Maharastra. According to state government report, Gujarat has more than 90,000 industrial units of chemicals, petrochemical, pharmaceuticals etc. Out of these, 65% are large and medium scale polluting industries' where as 45% of small scale polluting industries. Treatment facilities are not upto standard and hazardous industrial waste material is poured in river, which pollutes water. Even city like Surat has only 50% industrial units having treatment facilities . All the major rivers and streams like Kolak. Mahi. Daman Ganga. Amlakhadi etc. are in a bad state due to effluent discharged by industry. Polluted red colored water is seen flowing in the Sabarmati. released by the Common Effluent Treatment Plant (CETP) in Vatva.

Water quality deserves special attention because of its implications for affecting the public health .Poor quality water may be responsible for slow growth as well as gradual death of the plants. It may affect nutritional value of yield. Toxic and hazardous materials can also enter into plants due to poor water quality. which at the later may be harmful for human body. For example: Lead compounds cause human carcinogens and are brain wreckers.

Indian farmers are facing lots of problems like to maximize their crop productivity. in assessing water quality. selecting proper crop according to season. budget etc.. as they do not getting proper guidance. They need timely expert advice to make them more productive and competitive.

• **Interdisciplinary relevance**:

Urbanization. industrialization. agricultural practices etc. had important ecological impacts on the water quality. from both microbiological and toxicological points of view. Providing adequate amount of quality water will be the most critical challenge of the 21st Century. It is. therefore. crucial to examine all potential hazards related to the use of water by providing knowledge to environment people. planers. researchers and scientists. farmers etc. With the development of this proposed research work more reliable information will be available to person concern in easy way. This system has also great potential for wider application. Also. Farmer get proper guidance at each and every time so it reduce water pollution problems to some extent.

• **Review of Research and Development in the Subject:**

Developed countries like Europe and America. has a highly used ICT infrastructure that influences its agricultural research through the sharing of information and knowledge. and creation of new collaborations and partnerships for research. At the moment. Africa and Asia. is still developing ICT use in agricultural research. Connecting farmers to innovation in agriculture in the North has been accomplished through farm organizations and public sector agencies. In the South. several governments. such as Vietnam. Thailand. India. and South Africa. have initiated activities to link agricultural research to farmers through the use of new ICT. In both cases. the need for new intermediaries and agents for this linkage has come to fore.

Significance of the study

Water plays an important role throughout the food chain. from farms. to food processing plants and finally to consumers who drink water. It is. therefore. crucial to examine all potential hazards related to the use of water. Attention needs to be given to all types of water including the water used for drinking purposes, water used in different processes and types of foods and water used in agricultural practices. It is important that the issues relating to water availability, quality of water, treatment techniques and discharge of treated water are discussed on a priority basis to evolve a plan of action. **Finally, preventive rather than remedial actions should be emphasized.** Thus, to prevent this situation first identifying quality of water becomes important.

The proposed research work will support in decision-making for suitability and acceptability of water for irrigation by providing knowledge to researchers, environment people, planner etc. Knowledge of water pollution domain will be easily available through web based and mobile based interface. Thus, proposed research work can be useful for solving real problems related to water for benefit of society and optimum quality crop production minimizing health hazards can be obtained.

Objectives

The following objectives are achieved:

- To develop working model for better functioning of the specific agro-ecosystem by examining quality and evaluating the quality of water used for irrigation in the area.
- To identify water quality parameters and standards for irrigation and its suitability for crops
- To develop Web based interface for identification of irrigation water quality and suitability of crops.

Methodology used for achieving objectives:

Assessment of Water quality parameters like pH, temperature, etc and standards of parameters and heavy metals etc to be applied. As information related to these is not compiled and not available at one source it has collected through various sources like journals, books, pollution control booklet, experts etc. Also studied following models:

- ***PLANT/ds:*** Although development of expert system was started in 1960s, this was the first expert system in agriculture reported in 1983 by Michalski et al. (1983). It was developed for the diagnoses of soybean diseases in Illinois, USA. Thereafter development continued and now a day we find lot of such systems with different objectives.
- **Mango Information Network:** The Mango Information Network is an information service designed to manage the information needs of key players in the Philippine mango industry. This site is commodity specific and has monthly market information only on mangoes. Its central node is at the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development at Los Baños, Laguna, Philippines.

- **AgNPS (Agricultural Non-point Source)**: This is pollution model, which was developed by the Agriculture Research Service of the U.S. Department of Agriculture (USDA) in cooperation with the Minnesota Pollution Control Agency and the Soil Conservation Service of the USDA (Young et al. 1989 & 1994). The model was developed to analyze and provide estimates of runoff water quality from agricultural watersheds.
- **Agricultural Geo-referenced Information System in South Africa:** This is a web based information system that uses a geographical information system to provide agricultural information in South Africa. It is to be used by farmers through Multi-Purpose Community Centers that provide information access through tele-centers in South Africa.

National Status

- **Gyandoot**: Gyandootvi is an initiative of the Government of Madhya Pradesh to link villages to the Internet for information on governance, health, education and rural development, including agriculture, through the State Agricultural Extension System. It has content in Hindi and English.
- **Raitamitra**: Raitamitravii (Farmer's Friend) is an initiative of the State Government of Karnataka, set-up to provide agriculture-related information to farmers in Kannada. It is linked to the State Agricultural Extension System and State Agricultural Universities to provide better quality services to the framers of the Karnataka state

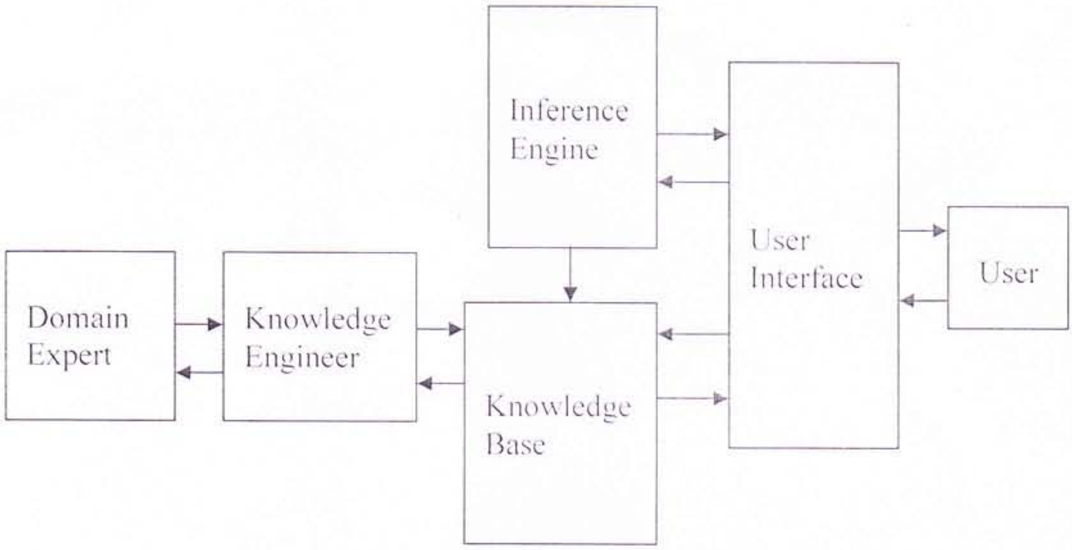
Classif-ication	Best use	DO (mg/L)	Coliforms (no./mL)	Temperature Degree C
A	Drinking Water, virgin source, no upstream use permitted	>6	<10/100	<15
B	Drinking water, upstream use permitted	>4	<100/100	<20
C	Water contact Sports, fishing	>3	<1000/100	NA
D	Noncontact sports, agriculture	>3	NA	NA
E	Agricultural and industrial use, water transport	>2	NA	NA

Simplified stream classification system

Sample Quality criteria for irrigation water values of parameters are as follow:

Quality Criteria	Class of irrigation Water				
	Very good	Good	Can be used	Can be used with caution	Unsuitable (bad)
Electrical Conductivity (EC) dS/m	0-250	250-750	750-2.000	2.000-3.000	>3.000
Variable sodium percentile (NA)	<20	20-40	40-60	60-80	>80
Sodium absorption ratio (SAR)	<10	10-18	18-26	>26	
Residue of sodium carbonate (RSC) mg/l	<66	66-133	>133		
Chlorides (Cl^-) mg/l	0-142	142-249	249-426	426-710	>710
Sulfates (SO_4^{-2}) mg/l	0-192	192-336	336-575	576-960	>960

Knowledge Based Expert system development process will consists of different steps Problem Identification. Knowledge Acquisition. Knowledge Formulation. Knowledge Representation. KBS Implementation. Verification and Validation. Deployment and Maintenance.



Architecture of KBS

- The architecture of KBS has to develop having main four components: User Interface. Inference Engines. Knowledge Base and Explanation Module.
- For intelligent Web based and Mobile based different layers like Presentation. Data. Information and Knowledge has to be developed

The brief description of each of the component is as under:

- Domain Expert: **Domain Expert is a person with full knowledge of the particular domain.**
- Knowledge Engineer: **Knowledge Engineer is a person who designs, builds and debugs the knowledge base with assistance of expert.**
- Knowledge Base: It represents a storehouse of the knowledge primitives available to the system. The knowledge stored in knowledge base establishes the system's capability to act as an expert. In general, knowledge is stored in the form of facts and rules, but the specified schemes used for storing the information vary greatly.
- Inference Engine: This is the most important software component of KBS. It evaluates and manipulates the facts and rules in a knowledge base. Then it makes associations and inferences resulting in a recommended course of action for a user. This process produces an inference chain, that is, linking of the various facts and rules needed to reach the conclusion. An inference engine uses two basic strategies or processes to create inference chains and reach conclusions- forward and backward chaining. A *forward chaining* inference strategy reaches a conclusion by applying rules to facts. The inference engine examines the premise of one rule at a time and scans the knowledge base to see if it contains any facts that satisfy the rule's condition. A *backward chaining* inference process justifies a proposed conclusion by determining if it will result when rules are applied to the facts. Thus, process starts with a hypothesis or goal and is said to be goal driven and this goal is compared to the conclusion of each rule in the knowledge base.
- User Interface: **User Interface is used to represent the knowledge in user understandable form. The software engineer develops User Interface.**
- **User:** User is an entity, which uses the KBS.

Development Process of KBS: Any problem solving in software must consists of activities like requirement specification for understanding and clearly stating the problem, design for deciding a plan for a solution, coding for implementing the plan solution, testing for verifying the implemented plan. For small problems these activities may not be done explicitly. Further, for large systems like KBS, where the problem solving activity may take years and years and where many people are involved in development, proper documentation and representation is required .

Various life cycles are described for KBS development process consists of different steps having its own unique feature and a correlation with other stage [These steps are given as under:

1. Problem Identification
2. Knowledge Acquisition
3. Knowledge Formulation
4. Knowledge Representation
5. KBS Implementation
6. Verification and Validation
7. Deployment and Maintain

Methodology for User Interface:

KBS to Identify water quality for irrigation	This is a prototype of a KBS to identify water quality for irrigation. It is developed on the purpose of giving assistance to users which include farmers, planers, scientists etc. whenever having problems regarding water quality. It is highly hoped that this system will give benefits to all users and will help in reducing water pollution problems.
Enter PH value: ---- Enter EC Value : --- Enter NAR Value: ---- - (Cont…..)	GOAL: This water sample is of very good quality and suitable for crops like lemon and grapes.

- Inference Engine provides a methodology for reasoning about information through first order predicate calculus of rule-based in the knowledge base and for formulating conclusions. Forward chaining data driven approach will be used in the proposed architecture where various functions like Promptuser. Deduce. Stepforward. Matchthen. Usethen. Testif. and Remember. are included. Deductive reasoning and modus ponens are used to reason and solve domain problems.

- Knowledge base containing facts. knowledge and rules necessary for understanding and solving problem from human experts in addition to facts provided by user during interaction with the system to assists and guides farmers. planners etc. has to be collected and categorized into five main groups: domain knowledge. preference knowledge. probabilistic knowledge. user data and process knowledge.

- The model will be built on a relational database that is located on a web-server keeping in mind access and database factors for storing facts.

- Microsoft Visual studio 2005 will be used for development for web interface.

- A J2ME tool will be used for the development of mobile agent architecture and its interface.

Methodology: To achieve above stated objectives following has to be done :

- Assessment of Water quality parameters like ph. temperature. etc and standards of parameters and heavy metals etc to be applied. As information related to these is not compiled and not available at one source it has collected through various sources like journals. books. pollution control booklet. experts etc. The collected information is stored in appropriate ways using **predicate logic** so that it can be saved. inferred. and manipulated at the later as and when required.
- KBS development process will consists of different steps Problem Identification. Knowledge Acquisition. Knowledge Formulation. Knowledge Representation. KBS Implementation. Verification and Validation. Deployment and Maintenance.
- The architecture of KBS has to developed having main four components: User Interface. Inference Engines. Knowledge Base and Explanation Module.
- For intelligent Web based and Mobile based different layers like Presentation. Data. Information and Knowledge has to be developed
- Inference Engine provides a methodology for reasoning about information through first order predicate calculus of rule-based in the knowledge base and for formulating conclusions. Forward chaining data driven approach is used in the proposed architecture where various functions like Promptuser. Deduce. Stepforward. Matchthen. Usethen. Testif. and Remember. are included. Deductive reasoning and modus ponens are used to reason and solve problems.
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- Thereafter, for maintaining consistency of this knowledge base ontology will be created and extraction of ontology using sample rule from Knowledge Base is done.
- Intelligent agents will be used in each component of Web-based as well as Mobile based has to designed and developed. .Primary concentration will be on agents like query agents, search agent, text agents etc.

Methodology for Web Based User Interface:

- The model is built on a relational database that is located on a web-server keeping in mind access and database factors for storing facts.
- The HTML-code is dynamically generated through server-side scripts. The KBS for water quality and crop selection is maintained inside these scripts.
- When using the system the user connects to the web server which processes the request and sends the result back as an HTML-page to the browser of the user. On the server, KBS for water quality and crop suitability apart from comparing the parameters values do lot more activities.
- These activities through intelligent agents were discussed at the later in this chapter.

Mobile based User Interface:

- A XML-based mobile agent architecture is used.
- The mobile phone user interfaces are developed using Java as a developing tool. A mobile agent system design based on the use of XML-based agent code, the UDDI registry for agent registration and lookup/discovery and XML Web Service calls for mobile agent intercommunication and migration.
- Using the built-in Common Object Request Broker Architecture (CORBA), data and execution requests are passed through back-end Java class and the resulting Java Beans. Communicating with the three lower layers – Data, Information, and Knowledge in the proposed architecture, CORBA collects and sends the requested water data.
- To simplify calls, input and output parameters are converted into XML strings by a customized XML parser. After the XML parser reassembles the settings and information from the requested weather data, the knowledge discovery algorithms are executed. Because the knowledge discovery methods are written in JAVA, the KBS uses Java Native Interface (JNI) to execute the methods as shared libraries. Upon its return, a separate C++ XML parser formats the result data.
- Finally, the back-end updates the KBS online interface with results presented to the user web browser or mobile screen. In mobile based user interface, working of all four layers are almost same

Methodology for validation and verification of proposed KBS : real case studies carried pout .

- Sampling of river water
- Sample water will be tested and analyzed in laboratory
- Data matched to knowledge stored in Knowledge base and store in knowledge base for further prediction

The first one will be undertaken to evaluate the quality of Sabarmati river water that was used for irrigation on a long strip of farming land located at outskirts of Ahmedabad city in the state of Gujarat. The second one was from water flowing through the effluent channel to Gulf of Khambat. Usually farmers are applying wastewater for irrigation for over a decade now. The outcome of the water quality has been taken into account to determine the correctness of crop selection suggested by the developed KBS.

Conclusion :

Water plays an important role throughout the food chain, from farms, to food processing plants and finally to consumers who drink water. It is, therefore, crucial to examine all potential hazards related to the use of water. Attention needs to be given to all types of water including the water used for drinking purposes, water used in different processes and types of foods and water used in agricultural practices. It is important that the issues relating to water availability, quality of water, treatment techniques and discharge of treated water are discussed on a priority basis to evolve a plan of action. **Finally, preventive rather than remedial actions should be emphasized.** Thus, to prevent this situation first identifying quality of water becomes important.

This research work will support in decision–making for suitability and acceptability of water for irrigation by providing knowledge to researchers, environment people, planner etc. Knowledge of water pollution domain will be easily available through web based and mobile based interface. Thus, this research work is useful for solving real problems related to water for benefit of society and optimum quality crop production minimizing health hazards can be obtained.

Thus working model for better functioning of the specific agro-ecosystem, identification of water quality parameters and standards for irrigation and its suitability for crops and Web based interface for identification of irrigation water quality and suitability of crops has been developed .

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