CHAPTER: 07

ARTIFICIAL INTELLIGENCE IN WATER RESOURCE MANAGEMENT SYSTEMS

MONIKA SINGH
@Faculty of Pharmacy, RBS Engineering Technical Campus, Bichpuri, Agra, Uttar Pradesh, India

PREETI MISHRA
@Faculty of Pharmacy, RBS Engineering Technical Campus, Bichpuri, Agra, Uttar Pradesh, India

AMIT YADAV
@Faculty of Pharmacy, RBS Engineering Technical Campus, Bichpuri, Agra, Uttar Pradesh, India

NAMRATA GUPTA
Faculty of Engineering & Technology, RBS Engineering Technical Campus, Bichpuri, Agra, Uttar Pradesh, India

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ABSTRACT

In the future, artificial intelligence (AI) will alter business processes and companies which will have the potential to solve important societal issues such as resource scarcity and environmental sustainability among others. The real value of artificial intelligence will not be found in the way it allows civilization to decrease rather than focusing on the intensity of its energy, water, and land use, in the way it supports and promotes good environmental governance practices. Artificial intelligence could be used to model water elements such water quality variables, evapotranspiration and evaporation, sediment, streamflow, rainfall-runoff, and lake or dams water level variations. The modelling of water variables by artificial intelligence is vital step in the water resources management in any aquatic environment. As a result, AI offers some potential research opportunities in the future for the modelling of water parameters. As the world's population continues to increase, the most important consideration is how to create the most of available water supplies. The decision-making skills of artificial intelligence may be used to achieve this optimization and automation. AI-based planning allows agencies and water agencies to better comprehend real-time loss of water and abuse, develop and implement extensive distribution connections, and the production of net revenues as the commercial goal using artificial intelligence. AI has the ability to provide instant remedies while posing no long-term threats to environmental protection. It is necessary to evaluate the influence of AI on the attainment of the Sustainable water resource management system.

Keywords: *Artificial intelligence (AI), Water resource management system.*

1. INTRODUCTION

The environment, which is a work of art in its own right, has been bestowed onto humanity. As time proceeds, our increasing demand for comfort has resulted in toxic water, unproductive land, and polluted air among other things (Xiang *et al*, 2021). As a result of this proclivity, we now find ourselves in this situation which necessitates the examination, quantification, and treatment of what it was like when it was in its most natural state. Therefore, Water pollution legislation were enacted to avoid the loss of natural water quality as early as the 1960s, and the need for water testing was recognised (Barry, 1969). The sources of surface water (such as rivers, lakes & Coastal areas) and water from the ground are the two types of water sources that exist (e.g., passageways and springs for water infiltration) (Fig.1). Because of their accessibility and availability, rivers have historically been the most widely utilised water supply, which has resulted in the development of most civilisations along river banks throughout time (Mustafa *et al*, 2017; Viessman *et al*, 1998).

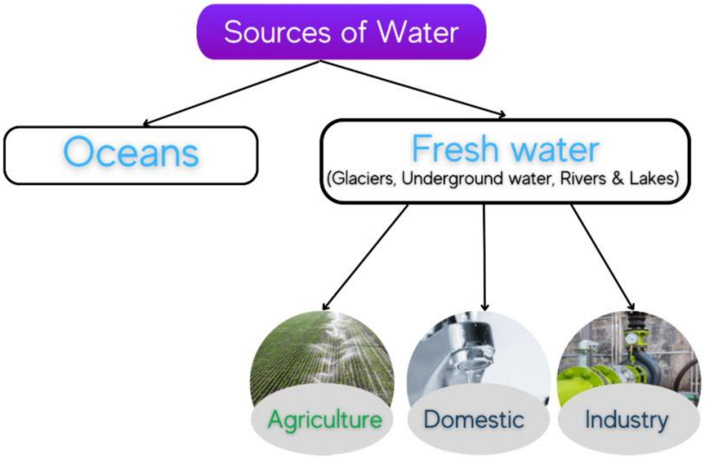

Fig. 1 Sources of water

An examination of the data revealed that the cumulative evapotranspiration exceeded the total overall rainfall, with the potential to have an impact on the yield of important crops on the island. Because of this, viable options for agriculture sustainability are required, such as supplemental irrigation, to resupply the irrigation needs as and when they are required (Afzaal *et al*, 2020). With the help of AI, we can solve such issues.

It is being developed and implemented new techniques for managing water resources challenges, which will include cutting-edge information storing capabilities dependent on computers, analysis, and straight information transfer to water system administrators and controllers for strategic decision making. This study will assess use of various Water Resource Management Decision Support Systems (WRMDSS) in water resource management and operations, as well as future trends. A WRMDSS combines data input, storing, and retrieve efficiency with robust data processing and decision-making capabilities, as well as a user-friendly interface, to provide a comprehensive data management system. As a result of direct connections between the DSS's data base and assessment modules, users are able to obtain the use of exercise models or data in a dynamic manner without the need for additional training. We employ interactive computer graphics (ICG) to assist with review duties and data validation, along with to communicate the outcomes of studies to non-technologically savvy executives. The user-friendliness criteria is particularly essential since it allows system administrators to circumvent intermediate computer operators, which is cumbersome and reduces user trust in the system. In the field of decision support systems, there is a broad range of methodologies that may be used to successfully Computers, database management systems, visual interactive modelling tools, as well as other techniques can all be used to assist with decision-making. Record-keeping and transaction processing have been done in the past. The applications of computers are distinguished from DSSs principally by the fact that, in order to be successful, they need a cooperative relationship between the users and the system (Sprague and Carlson, 1982). Thus, a decision support system differs from previous generation electronic data processing and management information systems in that it places a strong emphasis on making decisions rather than just collecting data. Expert systems of the newer generation, on the other hand, include artificial intelligence methods to automate the process of knowledge collection and strategic planning. It is here that the man-machine partnership is formalized with the goal of allowing computers to assist in judgement (Sprague and Carlson, 1982).

(AI) importance in water supply

Artificial intelligence (AI) is defined as "a area of computer science that is concerned with the modelling of intelligent behaviour in computers" Artificial intelligence (AI) or machine learning in the form of efficient water supply is primarily focused on decision-making tasks, such as how water systems can maximise data and information available to make a good decision while simultaneously increasing service delivery; optimising public investment; and reducing operating costs, which include environmental and social external costs. Utility companies are following in the footsteps of other businesses, mainly the energy sector, and doing so without often fully comprehending the underlying assumptions and ramifications of incorporating information and communication technologies (ICT) into their management.

The amount and quality of the water are believed to be the primary driving elements behind the functioning of the reservoir. There are a variety of elements that influence the amount and quality of water in the environment. Increased water demand, various uses, water pollution owing to fast urbanisation, rapid expansion of water resources, nutrient enrichment (eutrophication) and depletion of non - renewable water bodies, and rising expenses associated with water treatment are only a few examples of these concerns.

Recent years have seen an increase in the importance of evaluating seasonality, social, and biological issues in reservoirs managing, particularly in relation to climate change. For example, fuzzy set theory and neural networks provide models of stochastic and artificial intelligence (AI) techniques that may be used to construct decision support systems which can evaluate all of these complicated linkages and uncertainties (Chaves *et al*, 2002)

It is being developed and implemented new techniques for managing water resources challenges, which will include cutting-edge capability for software data storage, analysis, and direct data transmission to Decision support for water sys admins and controllers. The storage reservoir system has been effectively optimised while taking into consideration the uncertainties associated with the input 0loads. Furthermore, the employment of the Markov chain process allows for the effective handling of the stochastic properties of the influx.

Support vector machines, artificial neural networks, adaptive neuro-fuzzy inference systems, classification trees, and other data-driven techniques are focused on the application of artificial intelligence (AI) or machine learning techniques like artificial neural networks (collectively known as deep learning methods and their many variations) and so on. Using these approaches, which have been adequately trained on big data sets, it is possible to extract data and discover patterns without the usage of network equations (Mounce *et al*, 2015). It has been reported in the literature that a number of data based technologies for pipe burst monitoring in water bodies have been developed (Huang *et al,* 2015).

Hydraulic approaches are being used for variety of functions, including understanding as well as prediction tools, which are used to explain & predict what actually occurred in a specific location at a specific time in the water supply system without using instrumental and sensor data; (ii) forecasting tools, that is used to predict the "what if" set of circumstances for implementation and designing of the water supply system; and (iii) prescriptive tools, which are used for decision analysis systems, which are becoming extremely prevalent by recommending (Jenny *et al,* 2020).

Water Resources utilization in Microcomputer

In the field of water sources, microcomputer applications are being developed. No study of water resources management information or decision support systems would be complete without discussing the many fruitful applications of sophisticated multi purpose enterprise software. Minicomputers are now equipped with corporate software that may be used for a variety of tasks. These software programmes are regarded as significantly more consumer-friendly computer programming languages that allow for computation and quick programming, graph analysis of information and calculated results, and report compilation, in addition to spreadsheets (e.g., Multiplan and Lotus 1-2-3), word processing, and products in data processing packages. The amount of programming necessary to get useful and highly tuned outcomes is far less than previously thought. These software programmes have had a near-revolutionary influence impact civil engineering practise, in part due to its ease of use and time savings, which have led in decreased industry prices. James and Torno (1984), for example, have shown how examples of applications may be created in practically every aspect of water resources practise and civil engineering. More applications are being developed at a fast rate as well (Loucks , 1985).

Water Monitoring Networks in the Region

Regional water tracking systems are also being installed to assist with flood risk assessment as well as flood control responsibilities. In locations at risk of flash flooding, flash flood warning systems based on microprocessor technology for hydrological analysis and data sensing, networking, and processing of information have become more prevalent. For example, the ALERT-1 and ALERT-2 systems are examples of such systems, which were first designed by the National Weather Service's Sacramento, California, office and are still in use today (Curtis and Greecham, 1982).

To improve the effectiveness of their water management and planning efforts, a lot of states are employing modular water monitoring equipment. The Colorado geostationary management and tracking system, for example, can send instantaneously water resources information from major gauging stations throughout the state of Colorado, enabling for more efficient water management, as per the Colorado State Engineer's Office. Through a telephone line, computer terminals can connect to the computerised system from anywhere in the world. Water rights administration can be made more efficient with these data and application software packages, the compilation of computerised hydrologic records, and the collection of additional information for water resources management, like flood warnings and forecasting.

According to a report by the United States Geological Survey's (USGS) Water Resources Division, which is in charge of nearly 15,000 hydrologic and meteorologic gauging stations around the country. The new system, which will use microprocessor technology, is being developed by the USGS's Water Resources Division (Billings and Latkovich, 1982).

The United States Geological Survey (USGS) will offer this set of complementary equipment and modules, which can be designed and operated for a variety of functions, including collecting information and process, data transfer, and control systems.

Reservoir System Operations

The development of DSS for a long and famous history to handle complex river-reservoir systems. The Columbia River system, the Central Valley plan in California, the Tennessee Valley Authority, the Arkansas River system, the Duke Power Company, and the Lower Colorado River system are just a few of the many successful applications of computerised system's monitoring and analysing packages for water reservoir systems (Toebes and Sheppard, 1979). There are several additional instances of reservoir system WRMDSSs that may be found both nationally and internationally. Reservoir WRMDSS techniques were originally intended to be used as modelling techniques to explore as well as to evaluate various control system setups and substitute reservoir operation and maintenance policies. A multitude of mathematical methodologies of optimization, including as linear and dynamic programming, have been applied to determine the range of probable optimal designs/ plans. These plans can then be evaluated thoroughly utilising a variety of advanced software packages. Conservation and flood control efforts, as well as flood disaster prevention, supply reliability, water quality enhancement, hydro power production, navigational, and recreational aims, are all included in the evaluations' scope (Toebes and Sheppard, 1979).

2. DECISION SUPPORT SYSTEMS (DSS) FOR MANAGEMENT OF WATER RESOURCES

The use and usefulness of decision support systems in the water resources management is growing. Personal computers, large data bases, microprocessor-based data collection platforms (DCPs), colour graphics, computer networks, user-friendly softwares, and computer-based models are just a few of the technological advances gained attention with the use of computers to support water resource judgements. Pressure, water flow, and quality are all measured by advanced data gathering devices, as are a variety of other environmental and system factors. Data is transmitted in real time through satellite and radio, providing the most up-to-date data bases for accurate and rapid assessments. Water resource managers can swiftly assess several operation schemes and select a "best" strategy thanks to interactive computing and visual presentation features. The trinity of data subsystems, models subsystems, and dialogue management are included in a design framework for DSS development. A look at some of the WRMDSS examples that use this framework to illustrate their capabilities, technologies, and techniques is offered. The following are some instances of examples of examples of examples of examples of examples of examples of examples water supply system operations; regional water monitoring systems; Microcomputer applications; regional weather observation and forecasting; computer-aided planning systems; knowledge-based expert systems and reservoir system operations; are among the topics covered (Fig 2.).

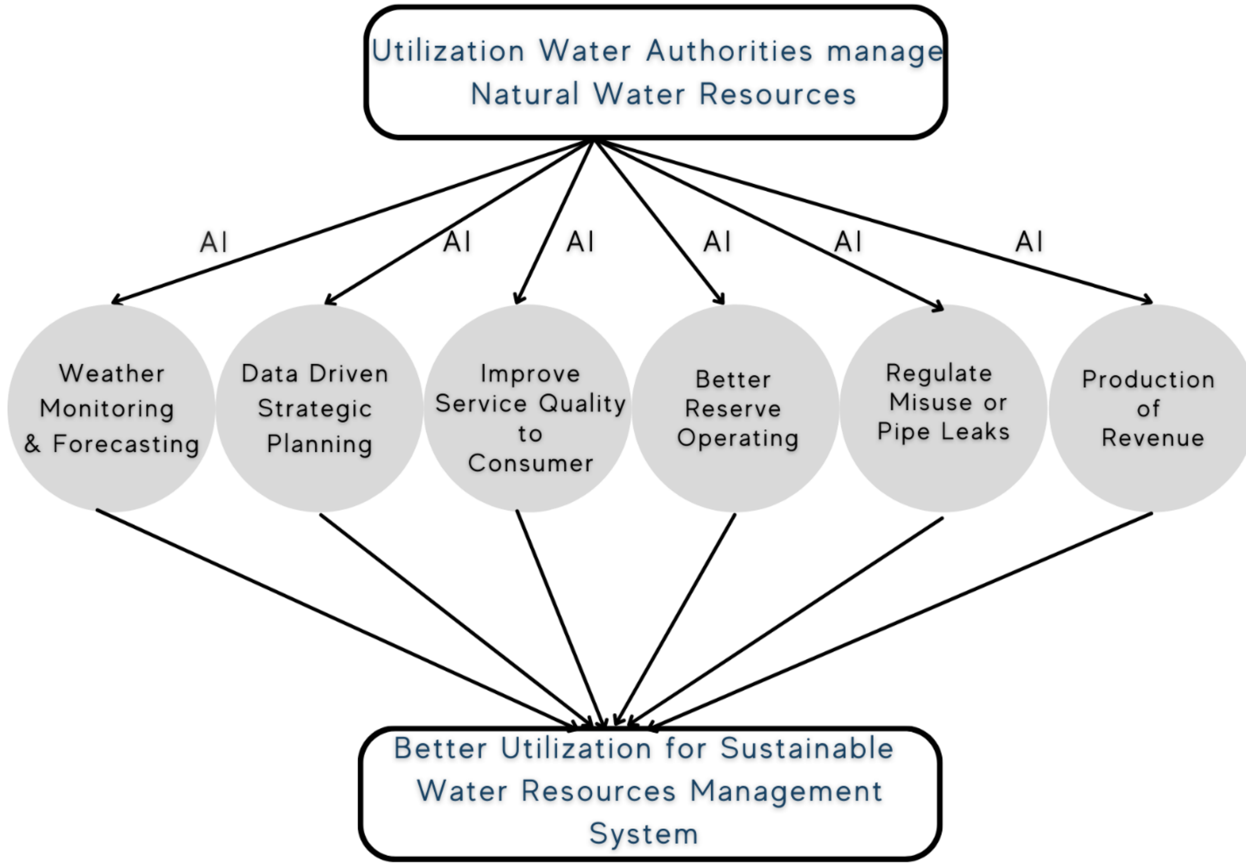

Fig.2 Role of Artificial Intelligence (AI) in Water Resource Management System

Water Supply

To increase their capacity for managing the system, numerous water distribution network operations administrations have always used computerised DSS. The systems' roles are similar in that they require close monitoring in the face of rising water demand, rising prices for additional storage and transmission infrastructure, maintenance and operation, and drought-related water-utilization limitations.

For these systems, computer-based simulation and optimization models, system monitoring, and interactive computer control systems have been created as a way of enhancing or improving water consumption performance and lowering investment and operating costs. The level of data collection and system modelling elements in a water supply system DSS built by the Melbourne (Australia) Metropolitan Board of Works. They've lately created an integrated computer monitoring, modelling, and control system that heavily relies on computer graphics for programs management (Cosgriff *et al*, 1985). The use of computer-based telemetry and modelling methodologies has been credited for revolutionising the design and operation of Melbourne's water delivery system, as well as providing the foundation for various price-effective improvements. These level of innovative tools are said to have increased feedback and analytical techniques, leading to a better understanding of the operator training, hydraulic system, and the better connectivity of a wide range of administrative and technical skills.

Reservoir System Operations

It has a long and famous history of developing DSSs for the regulation of complex river-reservoir systems. The Tennessee Valley Authority, the Arkansas River system, the Columbia River system, the Lower Colorado River system, the Duke Power Company and the Central Valley project in California, are just a few of the many successful reservoir operational process applications of computerised systems analysis packages (To ebes and Sheppard, 1979).There are several additional instances of reservoir system WRMDSSs that may be found both nationally and internationally. In the beginning, reservoir WRMDSS approaches were created as Plan assists in the discovery of possible reservoir system design configurations as well as the investigation of different reservoir monitoring system policies. A number of mathematical optimization approaches, including as linear & dynamic planning, were used to determine the range of possible optimum programmes. More advanced simulation models can then be used to further investigate these plans. After the reservoir systems were built, WRMDSS techniques were utilised to aid in their operation, with latest information being linked to computational models. The assessments address conservation and flood control efforts, as well as flood disaster minimization, navigation, supply reliability, hydropower production, water quality recreation & enhancement goals (French *et al,* 1979; Johnson, 1980).

In a case study, ICG methodologies were utilised to assist in the definition of a river-reservoir system, the coordination of model applications, and the analysis of model outputs as an illustration of reservoir operations modelling for judgement support (French *et al*, 1979; Johnson, 1980).These ICG techniques are an example of WRMDSS advancements targeted at overcoming the computing constraints associated with the development and resolution of complex analytical models in the area of hydrogeology and natural water resources. The ICG software package, provides a very flexible and semi-automated way for building a reservoir system for river and producing a number of analytical tools. As a consequence of the ICG techniques, decision - makers may get the findings of a computerised analysis model, as well as incorporating the decision- making preference judgments into reservoir operating and regulatory frameworks procedures, among other things.(French *et al*, 1979; Johnson, 1980).

Researchers at Cornell University invented the phrase "computer-aided planning" to describe computer programmes that help evaluate and assess the environmental and economic implications of various land-use plans and water management, as well as to access decision-makers better comprehending these consequences. It can be compared to computer-aided design and manufacturing (CAD/CAM), which are similar but were quite well methodologies in engineering production and design. The Cornell CAP (Computer-Aided Planning) package, which is made up of a network of subroutines that are connected together, handles the input and maintenance of geographical and other information relevant to land-use and water strategic management & planning (Loucks, *et al*, 1985).As a way of forecasting the consequences of alternative strategies, subroutines are also included for doing different analysis on these data bases. There are many subjects covered by the models, including Quality of water, flooding runoff, reservoirs managing, and land use planning are all issues that need to be addressed.

The geographic data base manager assists with the data input to the model before it is preprocessed into a format that is consistent with an analytical model as well as the postprocessing of output. It is possible to enter two-dimensional geographic data into computer memory by either using a digitising pen and tablet to either scanning using a video camera or tracing data source into computer memory Vector and raster presentations of mapping water resources components and data can be merged via attribute extraction, scaling, and overlaying to produce composite maps along with data sets that can be used for model parameter identification and plan development. An interactive menu driven set of instructions is used to keep control over all of these computer-assisted model-building processes. There is a built-in "Help" command that may be used to offer guidance and instruction while using these commands (French *et al*, 1979; Johnson, 1980).

The Cornell CAP programme was intended to make it easier for administrators, strategists, and politicians to research, synthesis, and evaluate solutions to water resources and the ecological difficulties and concerns. The adoption of CAP techniques has helped Long Island land-use planning operations, watershed flooding prevention planning, and water quality monitoring planning. Developed capabilities for geographic data management are intended to take use of the enormous current data base that is accessible in mapped forms. In addition, many characteristics of Water resource systems can be depicted visually on a map, which is a feature that facilitates communication and comprehension. The CAP programme can be run upon the microcomputer, providing it more portable and cost-effective. Water resource planners and managers, as well as other interested parties, could benefit greatly from the availability of low-cost, easy-to-use technologies (French *et al*, 1979; Johnson, 1980).

Weather Monitoring and Forecasting in the Area

PROFS (Program for Regional Observing and Forecasting Services) is a NOAA (National Oceanic and Atmospheric Administration) research programme based in Boulder, Colorado.

Which is devoted to improving operational brief weather forecasting services. Developing a system that can gather, analyse, and display data essential for the technique that has been adopted thus far has been analysing meteorological occurrences in an actual time, operational work environment.

There are five fundamental data streams that are fed into the PROFS facility:

1. The radar system collected data on reflectance and Doppler radar velocity.
2. Image data from satellites in the visible and infrared spectrum.
3. Upper air data from the NWS (National Weather Service), surface observations from the Diagnostic and predictive items from the National Meteorological Center (NMC).
4. Surface-based remote probes (profilers) are being developed for measuring temperature, wind profiles, and humidity.

Creating a computer-controlled network, automated earth's meteorological stations. The computing system includes of a vast number of networked computers linked together via dual-port storage devices, phone lines, or direct computer-to-computer interconnections (also known as a LAN).With this distributed computing environment, it is possible to handle large amounts of data in real time, as it is received from multiple sensors. A significant component of the PROFS research program's success has been the development of an efficient, state-of-the-art enhanced workstations to assist forecasts to generating faster and better predictions of severe weather events. A menu-based touch screen system which is user-friendly and one way to achieve this. The forecaster may quickly display colour graphic images of data monitoring products for national, regional, as well as local scenarios using this method. Images can be animated in a time series. It is possible to create user-controlled overlays of multiple data sets by employing colour graphic displays.

These capabilities, when paired with the ability to undertake fast data import, analysis, and graphical presentation of data, as well as analyse output, give the forecaster the tools he or she needs to combine human interpretive and judgmental talents with computer numerical processing capability. As a result, judgments on short-term occurrence forecasts may be implemented more efficiently. Technologies that are similar to these are influencing the design of the distribution system for extreme weather condition (Johnson *et al*, 1981).

Water Resource Management Expert Systems

The phrase "knowledge-based expert systems" (KBES) refers to computer systems that use a.i. approaches to mimic the efficiency of a knowledge engineer in a certain problem-solving area. Expert systems are considered as having tremendous promise when applied to ill-structured issue areas like engineering design, where explicit methodologies may not appear or typical computer programmes have extremely limited problem-solving capacity (Johnson *et al*, 1981).

Reservoir water monitoring by ANN model

It's difficult to model water quality, for example, because of the vast number of elements that really should be established, the nonlinearity of the processes involved, and the limited amount of data that is currently accessible(Maier *et al*, 2000)..

Because of a lack of sufficient data and in consideration of the goal of the study, The provided model does not take into account the temporal dependency of the reservoir water quality model. However, as previously stated, not accounting for time dependency makes linking the ANN model for quality of water and the SDP model easier, because the ANN model may be used in combination with the backwards computational method that is suggested for SDP modelling to improve accuracy.

DO, BOD, TP, TN, and chlorophyll are all simulated using the ANN model. The following quality parameters are modelled by the ANN model: (CHA). Because these parameters, as well as the multiple input variables, have some interdependence, it is thought that a single ANN model will be the most realistic representation of these interrelationships.

A procedure of trial and error is used to determine the proportion of hidden units. Keep in mind that if you don't have enough data for training and validation, you should prevent utilising a high number of units which are hidden in hopes of preventing overfitting your model (Maier *et al*, 2000).

Towards Long-Term Water Management

The contemporary water management recently concentrated on the issue of unsustainable consumption. Water policy has mostly evolved independently of environmental policy (Wescoat and White, 2003). Water management for agricultural purposes, urban development, forest management, and environmental quality has been fragmented as a result of sector-based management of water for agricultural purposes, urban development, forest management, and environmental quality. A considerable body of work has been done to address these concerns, starting from basic water poverty and water stress indexes to studies of water footprint of wide range of economic behaviour (Falkenmark, 1989; Sullivan, 2003). As from early 1990s to the 2020s, international organisations namely the Global Water Partnership have advocated the integrated water resources management (IWRM) model as a sustainability techniqueas depicted in Fig 3. (Hoekstra, 2013). After a decade of acceptance, the International Water Resources Management (IWRM) movement has come under fire for being too broad in reach and In terms of content, it's far too apolitical (Mollinga *et al*., 2010). The domain of recent studies holds a few bright prospects, however the data tends to be based on locally sustainable antecedents in a framework that political ecology characterises as fundamentally global and locally sustainable (e.g., Crate, 2011; Gleick and Palaniappan, 2010). Present study that which connects agronomic - ecological landscapes as well as irrigation facilities has been making the connection between water and agriculture, along with sustainable development for a long time (Zimmerer, 2012). One of the most exciting academic tasks is determining how locations might benefit from the triumphs of other places and previous periods (Kenney, 2005). Despite the enormous scale of information, technologies, and social connections, official comparison approaches have rarely been used to study them (Mollinga and Gondhalekar, 2012; Wescoat, 2009).

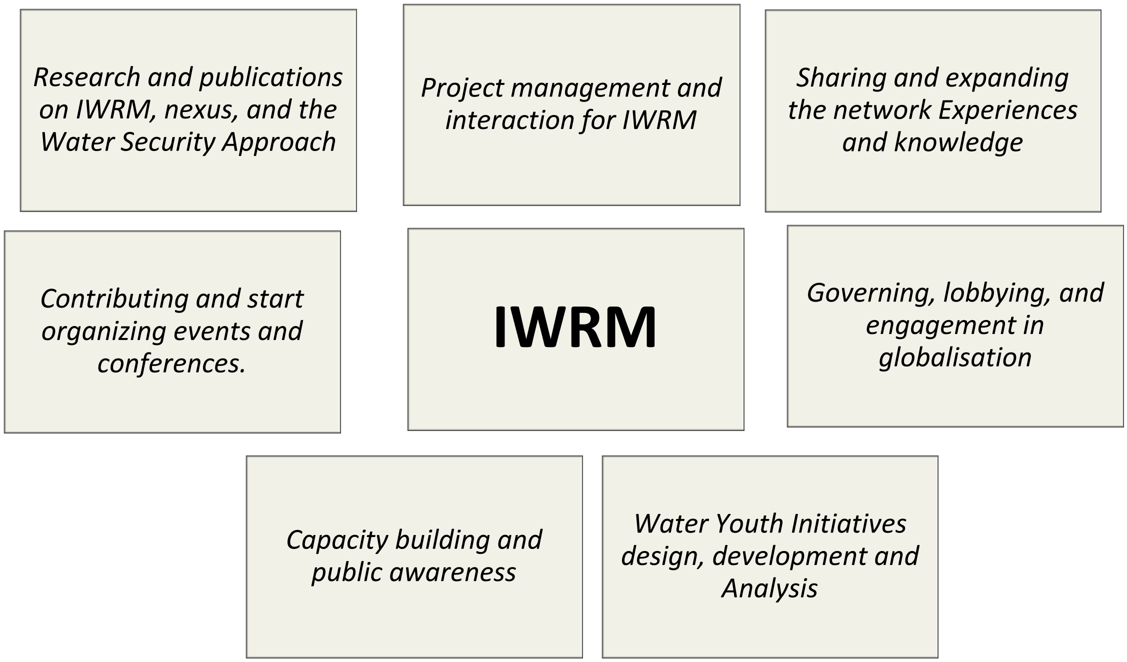

Fig 3: Integrated Water Resources Management (IWRM) tools

The following functions are provided by AI algorithms:

I. Measurement and management network architecture that is most efficient Tracking and monitoring networks are the digital equivalents of physical pipes, allowing water utilities to move to the digital information age while preserving operational efficiency. Furthermore, this quantitative method to network instrumentation establishes a clear relationship between ICT expenditures and anticipated operational benefits, giving a solid foundation for a cost–benefit analysis that is frequently lacking.

II. Determination of actual and apparent water losses using numerical methods. Artificial intelligence algorithms can offer geographical information on the quantity and kind of water that has been lost. After attributing a particular level of uncertainty to the existing data, Using the given data, the AI algorithms next attempt to identify the network's most likely state. It is possible to distinguish between several types of water losses based on the density and frequency of readings in each network sector (for example, pipe leaks vs illegal use). Though it cannot totally replace the use of field equipment to pinpoint water leakage or interconnections, it can save time and money by reducing the need to deploy huge amounts of leak detection equipment.

III. Savings in energy use. Savings on energy can be made by determining a most cost-effective investment in a particular system (such as a pump replacement or enhanced storage capacity, or a change in the energy contract, for example).

IV. Development of contingency plans and procedural guidelines Water utilities plan ahead of time to deal with crises and reduce the effect on their customers' lives.

V. Consumption patterns are classified, and future demand is forecasted. Water demand forecasting at a node or a set of nodes is made possible by artificial intelligence algorithms that learn and improve as more data becomes available.

VI. The majority of water utilities have a well defined plan for combining maintenance and replacement in order to maintain optimum service levels while reducing costs. Taking proactive steps instead of reacting to unpredictability in the external environment is the goal of active asset management (Mollinga and Gondhalekar, 2012; Wescoat, 2009).

Water Management Microcomputer Uses

1. **Sub - system of data** : Spreadsheet data entering, equation building, and calculations are assisted by full-screen, interactive editing, which allows for faster processing. Input, processing, and change of data files are all made possible using database administration software, which is very adaptable.

2. **Models subsystem :** In this category are general-purpose spreadsheet software programmes that may be used for a broad spectrum of engineering utilizations, like urban drainage, sewer design, and waste water treatment plant –system operations. The use of spreadsheet data workup files that may be read by microcomputer simulation applications.

3. **Managing the dialogue :** Command selection via a menu. Built-in "Help" explanations. Easily accessible formatted reports. Data and analytical results are represented graphically. Menu command selection using interactive devices (e.g., "mouse," light pens).

4. **Final Thoughts :** Engineers without substantial programming skills can benefit from user-friendly software products. Significant time and cost savings have been gained. Computing capabilities are widely available due to low-cost software and desktop microcomputers.

Flood Warning Systems for the Community

1. **The subsystem of data processing** : To measure rainfall volumes and river levels, low-cost microprocessor-based DCPs are being deployed. Digital data transmission from the DCP to a repeater station within line of sight using radio telemetry. It is possible to get data automatically via a personal computer at the local agency in charge of issuing the warning.

2. **Constructs a system model :** Automatic rainfall, rivers stage, and rate of variance threshold testing. River flow estimation methods for river damaged zones. Tabulations of data in summary form.

3. **Maintaining control of the conversation :** A graphic and tabular representation of the river stage in relation to the warning levels. Limited ability to participate in debate. This section covers data query procedures for summary tables.

4. **Final thoughts Remarks :** Reduced cost of a latest generation of microprocessor and microcomputer technology is being employed to obtain data locally in a short amount of time, which is an industry trend (Crate *et al*, 2011).

Managing the Reservoir System

1. **The component of data processing:** In certain basins, there are actual-time river and reservoir level monitoring systems. Data entry, editing, and assessment are all sped up using the digitising tablet as well as other ICG technologies.

2. **The user can also utilise the graphical menu commands to access the resident data base :** In the second subsystem, models, flood control operations and simulation models of conservation are utilized to evaluate different operations plans. Screening models for the best potential designs using optimization techniques. Model have automated and direct access to database data. The capacity to formulate and connect a variety of models with great flexibility.

3. **Controlling the dialogue:** Through the use of command menu pages on digitising computer graphic display and tablets displays, users can coordinate the formulation and execution of models, as well as the evaluation of output results. Data entry is aided by the use of control menu pages and digitising tablets. Interactive modelling management and graphic representations allow decision makers to engage and learn from their mistakes.

The DSS design framework guides the creation of the WRMDSS, which is divided into three subsystems: (a) data, (b) models, and (c) conversation managing (Johnson *et al*, 1986).

Subsystem for Information Technology

There are many tendencies that may be seen in data subsystems. In recent years, the introduction of low-cost microprocessor information gathering platforms has a considerable impact on the tools and methodologies utilized for data collecting or DCPs. Community state-wide water management information systems, flash flood warning systems, and river-reservoir operations and monitoring systems are all being expanded at an increasing rate because to enhanced abilities of these DCPs, real-time reporting modalities, and telecommunications approaches. Satellite, radio, meteorbursts, telephone – landlines etc among other telecommunications modalities, are presently in use. The software elements among these systems are often improved in order to attain lower error rates and faster transmission range (Johnson *et al*, 1986).

In terms of capability and universal accessibility, remote sensing techniques are likewise progressing. NEXRA (new generation radar) is the name given to Doppler radar systems that will have overtaken existing radar systems by the end of this decade and will provide better statistics on storm dynamics on a regional scale, including rainfall. Satellite information is only of limited utility when integrated with hydrologic models in their current state, according to the findings of a study conducted for NASA (Peck *et al*, 1982). Although satellite imaging can not give a direct assessment of general storm patterns and movement, it does provide information on terrain features, vegetation cover, and the total area covered by snow. Satellites, of course, are a critical connection in the transfer of data from ground sensors to data archiving facilities and vice versa. Increased computer memory capacity, as well as CPU designs that support distributed and parallel computing, make it possible to handle the huge volumes of data that have been collected. The data collected from all of these sensors is of varying quality, which is a topic of controversy. Despite the extensive usage of low-cost telemetry DCPs all over a watershed, field help is not always available to ensure that the sensors are delivering trustworthy data. One response to this challenge is to increase the redundancy of reporting (for example, by evaluating reported flows in relation to upstream and downstream gauges). Error-checking algorithms may be included into the data intake software to provide system operators with early warning of potentially problematic data. Engineers who have been trained and have extensive expertise can assess the quality of the data. A computer visual display and database management software are used to assist the engineer in the data evaluation process in this setting(Johnson *et al*, 1986)..

Sub - system of Modeling

In a lot of areas, the model subsystems is still making development. Particularly significant is the rise of minicomputers and overall business software products. These microcomputer spreadsheet, graphics, database management, and word processing packages for many engineering applications, as well as for many other fields, provide a powerful user-friendly means of quickly accomplishing water resource analyses and designs with the bare minimum of programming effort. Microcomputer memory capacities are continuing to grow as their prices are decreasing. Future microcomputer workstations are planned to include, among other things, a large high-resolution colour graphics projection, a large amount of memory, more consumer user interfaces, reduced price data storage, and the capacity to interface with several communication channels (Crate *et al*, 2011). It is intended that making such technology available to water management, planners, and executives will increase productivity, enhance the quality of analysis & designs, and aid in the overall management and planning of water resources. Some standard applications software that was previously only available on mainframe computers is now being ported to microcomputers [for example, the Corps of Engineer HEC (Hydrologic Engineering Center) programmes].The general adoption of the HEC and other conventional models is a trade-off against the possibility for speeding calculations, data input, and programme structure, which is a trade-off as well. Data preparation chores for many software programmes may now be partially automated, allowing the user to interface with the programme and simply perform duties such as data inspection,While preserving interactive user control, the input data set is prepared and changed. It should be understood that developing a user-friendly application software for a computer model takes a lot of time and effort. The cost of this task reflects the necessity for the programmes to be used regularly and implemented on widely available hardware, which are both necessary. It has been demonstrated semiautomated access to data required as input for application models can be found in a variety of disciplines and application models.Visual interactive modelling (Bell, 1985), a new operations research approach that relies on the availability of computer graphics hardware and software, is becoming more popular.

Preprocessing and postprocessing of data enable for the building of models and model connections that are as flexible as possible. Visualization tools of data and analyze conclusions allow the engineer to focus here on assessment rather than data validation (for example, FORTRAN formats), examining large volumes of printed copy, or wait for batch systems to complete its output. Technical challenges include the problem of suitable display design (i.e., comprehensible representations), the complexities of graphical software, and model complexity limits resulting from the restricted capability of a graphical display (Bell, 1985).However, the lack of standards in the portability of a created system for usage on other computers continues to be an issue. The ability to solve massive sets of simultaneous equations, for example, will almost certainly continue to be required for certain sorts of analysis, which will continue to be performed on mainframe computers with restricted interaction capabilities. Operation and processing of multiple channel data, such as that required by Doppler radar meteorological forecasting systems, would also need a significant amount of computer power to be carried out. The advancement of computational architectures and parallel processing methods will allow these processes to be completed in a shorter amount of time. Although expert-system software is starting to be created for microcomputers, it is still considered more of a research tool than a practical one at this time.

The development and deployment of these technologies for water resources concerns is on the rise. As an example, the job of data verification is one that is seen to be suitable for the use of artificial intelligence methods. Expert systems will become more widely used when more testing and adoption by users takes place (Johnson *et al*, 1986). In practise, better, more exact, and much less expensive computations are on the horizon, as well as this promise will only grow in the future. With the availability of more processing capability and more intuitive software, using computers will become less difficult as well as more cost-effective. Some experts (Lilien, 1985) are concerned that the rapid development of models and the simplicity with which they may be used would lead to an increase in the number of erroneous applications.

Another benefit of a delayed turnaround compared to past projects was that more time could be spent on model building, specification, and testing, resulting in higher quality (Johnson *et al*, 1986). In order to address these concerns, conventional processes for determining model reliability should be developed and implemented, as well as training for model credibility assessors (James and Robinson, 1981). Understanding the sources of data and theoretical foundations for such investigations, as well as being eligible to utilize models calibration and validation methodologies to the data, is the engineer's role. On the contrary, it is thought that properly constructed and implemented WRMDSSs were genuinely organised to improve the engineer's capacity to do essential model-testing tasks and to boost the model's trustworthiness.

Management of Dialog

The usage of computer processing power has been found to benefit from improvements to the man-machine interface. Simple-to-use and intuitive-to-operate computer software and hardware make computers more accessible to a wider range of individuals without requiring extensive training. More significantly, these user-friendly features allow users to build confidence in the model and include their own judgement into the modelling process. Human-computer interaction technology is expected to advance further. As touch displays, voice commands, & image recognition technology and software become more widely available, it will become less expensive and more broadly adopted. The rising availability of microcomputers and general-purpose software will be a prominent trend in the near future (Crate *et al*, 2011).

CONCLUSION

Water authorities around the globe are rapidly transforming the way, which is being driven by the internet, big data, and artificial intelligence algorithms. Using an amalgamation of artificial intelligence numerical tools and human technical expertise, water authorities would become more content-efficient by transforming the data into a simpler execution, enhancing data-driven strategic planning, and improving service quality of customer. Creating a "smart" water system requires more than just technical expertise in data integration; it also demands an entirely corporate structure as well as entirely new sets of operating processes that have the support of both the customers and staff. An completely new set of nationwide sector regulations is required to sustain the transformational change of the water sector; more specifically, improved governance as a result of organisational reconfiguration and improved regulation is required to ensure cost-effective execution.

Therefore, several more water authorities, especially in developing nations, have digital capabilities that are not especially valuable for day-to-day operations and do not provide a real justification to their customers as a result. A accelerated, rational, and goal-oriented approach should be taken when transitioning water utilities to digital technology. By launching low-risk along with low-scale pilot projects, water utilities can evaluate the potential benefits of artificial intelligence techniques while simultaneously assessing their technological capacities and developing a realistic information and communications technology road map. Big data and artificial intelligence algorithms are promising alternatives for water utilities, and they should be tested in ongoing activities in order to improve water resource management outcomes.

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