<u>Proposal</u>

for

A2-P1: Decision Support System for Water Resource Management
जल संसाधन प्रबंधन के लिए निर्णय समर्थन प्रणाली

Development of a Small Rivers Management Tool (SRMT) for Holistic Water Resources Management in India

By

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Project Summary

This project proposal addresses the requirement of a specific decision support system (DSS) to bolster water governance, optimum decision-making, and advancing towards the achievement of SDGs, Focusing on comprehensive analysis-based solutions to manage aquifers and surface water and fostering stakeholder engagement. The DSS required for holistic water resources management will be created by integrating sophisticated statistical and simulation models to derive parameters for decision-making, providing policymakers with flexibility and easier operation. The small river basin scale management scenarios will be addressed in a flexible modeling environment to analyze, observe, and forecast the hydrodynamic and hadrochemical variables. The socio-economic dynamics will be addressed through a system-thinking approach using a coupled socio-hydrological model.

Associate Missions: Jal Jeevan Mission, Atal Bhujal Yojan, National Hydrological Project, Jal Shakti Abhiyan, National Groundwater Management Improvement Program-2, AMRUT-2.0

Introduction: DSS Framework

The global water crisis is exacerbated by unchecked urban expansion and the impacts of climate change (Doshi & Sharma, 2022), making water governance a matter of paramount importance. Water governance is a complex problem arising due to many stakeholders and an even more significant number of non-linear, dynamic interactions among these stakeholders across different economic, social, ecological, environmental, and political domains and feedbacks within the bio-physical system. The major challenges faced by water resources can be summarized as: Increasing demands and hence over-exploitations, Land use change, Direct discharge of liquid waste, Emerging pollutants, Solid waste in water, Ecological vulnerability, Climate change.

This complexity, coupled with information asymmetry, delays in information exchanges, etc., often leads to “unwanted consequences” such that well-intentioned interventions worsen the situations they aim to solve (Bugalia et al., 2021, 2023; Prasad et al., 2022). To avoid the “unwanted consequences”, a holistic understanding of the system is necessary, underpinned by strong theoretical and practical tools based on principles of Systems Thinking. Systems thinking is “a way of making sense of the world’s complexity by looking at it in terms of wholes and relationships rather than by splitting it down into its parts.” By viewing the river and its ecosystem as interconnected components of a larger system, many previous academic studies have used a robust and systematic method embedded in principles of systems thinking, i.e., System Dynamics (SD), to develop a holistic plan and leverage synergies for various problems related to river rejuvenation, river recreation, and wastewater management (Phan et al., 2021).

Since the Boon Freshwater Conference in 2001, the world has increasingly recognized the importance of water governance. Various sustainable approaches, including IWRM in the Netherlands and the “One Water approach” in Singapore, Australia, and the USA (Pokhrel et al., 2022), have emerged to address these challenges. Water-sensitive cities (Brown et al., 2008), green infrastructure, and sustainable urban drainage systems (Doshi & Sharma, 2021) have gained prominence for effective water governance. The 6th Sustainable Development Goal

(SDG 6), outlined by the United Nations (UN) in September 2015, aims to ensure the availability and sustainable management of water and sanitation for all (UN, 2017). This goal is closely interlinked with SDGs 11 (sustainable cities and communities), 14 (life below water), and 15 (life on land). According to the United Nations Environment Program (UNEP) in 2021, India and neighboring countries, including Afghanistan, Bhutan, and Nepal, exhibit low scores in IWRM implementation.

A robust decision support system (DSS) is essential to solve water management problems and their planning comprehensively. A DSS is a computer-based tool that helps to make informed decisions by providing comprehensive data analysis, modeling, and simulation capabilities. DSS integrates various data streams, such as hydrological, hydrogeological, meteorological, and socio-economic information, to support complex decision-making processes.

The Decision Support System (DSS) will rely on high-quality input data from established sources such as the Central Water Commission (CWC), India Meteorological Department (IMD), Water Resources Information Systems of India (WRIS), and remote sensing data from NASA's MODIS and Sentinel satellites. We will make sure that data gathered from these sources undergo pre-processing, including outlier detection, removal of erroneous readings, and interpolation where necessary, ensuring spatial and temporal consistency. Localized data such as groundwater levels and surface water quality data will be collected via in-situ measurements and sensor-based networks. These will follow standardized methodologies, ensuring high-resolution measurements appropriate for hydrodynamic modeling. Ground-truthing will be performed to validate remote sensing data and simulation outputs against field observations. By comparing satellite-derived parameters with on-site measurements, we will ensure model accuracy and maintain data integrity across datasets.

To validate the approach for developing a decision support system (DSS) for water and wastewater management, we draw from several key studies that demonstrate effective methodologies in this field. The first example is the development of a DSS_IWWM, which integrates wastewater treatment technology selection and reclaimed water planning, tested with data from multiple Indian cities, including Lucknow, Prayagraj, and Agra (Srivastava & Singh, 2024). This system's validation showcased its sensitivity to local resource scenarios and its capability to guide technology selection based on influent quality and target criteria. Another relevant study, (Maurya et. al, 2018) focusing on a decision-making tool for wastewater treatment technology, proposed a framework for selecting appropriate technologies based on reuse options, validated with data from Varanasi. This tool emphasizes practical decision-making in wastewater treatment. Additionally, the mDSS developed under the European MULINO project illustrates the integration of hydrological models with multiple-criteria evaluation procedures to address complex water management decisions (Mysiak et. al, 2005).

Most importantly, India-WRIS (https://indiawris.gov.in/) stands out as a comprehensive national water resources information system that offers a standardized GIS framework essential for the management and analysis of water data across India. Initiated through a collaboration between the Central Water Commission and the Indian Space Research Organization, and significantly enhanced under the National Hydrology Project, India-WRIS integrates a vast array of water-related information into a single, accessible platform. This system supports the National Water Policy's goals by consolidating data on water availability, quality, and usage, thereby facilitating more informed and efficient decision-making processes. By aligning with national policies and addressing the challenges of spatial and temporal water data variability, India-WRIS plays a pivotal role in improving water resource management. The system's ability to integrate diverse datasets—ranging from hydrological measurements to water quality and usage statistics—ensures that stakeholders can make well-informed decisions that support sustainable water management practices. This alignment with policy objectives and its role in centralizing water data underscore its importance in validating and enhancing decision support systems (DSS) for effective water management.

Potential Application of SRMT

The SRMT will have a wide range of applications based on the stakeholder's requirements. The specified modules will deal with a defined problem path using minimal inputs, yield results, and ready-to-use reports. While the front end will be simplistic and specific to the designed problem, the back end will work holistically by interacting with all the affecting hydrological, social and hadrochemical fluxes using an integrated model (IM). The submodules will be designed based on stakeholders' requirements, and the IM will be formulated based on academia's expertise in depicting the co-creation environment of SLCR.

The major application of the proposed tool will support the interventions that are being taken to revive small rivers in India. The modules are designed to generate suitable solutions and interventions for the objectives in **Table 1**. The individual module will address specific problems by taking a holistic decision-making approach.

Major Objectives:

1. Development of a Data Management Framework
2. Development of Integrated Hydro-Computational Modelling Framework
3. Development of a System Dynamic Modeling Framework
4. Development of a Graphical User Interface Framework

Table 1. Major SRMT modules and outcomes

Modules	Submodules	Applications	Outputs
Groundwater management (GWM)	Groundwater potential assessment	1. Suitable pumping location (point-scale analysis) 2. GW potential zones	1. Suitability 2. Predicted water quality 3. Predicted yield 4. Alternatives
	Resource Estimation	1. Regional scale quantification 2. Water quality assessment 3. Vulnerable zones	1. Assessment report 2. Capture maps 3. Maps and data
	Managed Aquifer Recharge	1. Regional to local scale water estimates 2. Effect of climate change on natural recharge and discharge 3. Site suitability of MAR applications 4. Optimized solutions	1. Budget estimates 2. Analytical and forecasting results as plots and data tables 3. Maps 4. Report
	River Aquifer Interaction	1. Baseflow estimation 2. Effect of climate change on lean flow and their mitigation planning	1. Accurate baseflow estimation at various spatial scales 2. Capture maps and river protection zones 3. Report
River Water Management (RWM)	Resource Estimation	1. Water availability 2. Volumetric flux and storage estimation 3. Water quality assessment 4. Vulnerable reaches and water bodies 5. Short-term peak contamination assessment (during festivals)	1. Assessment report 2. Maps and data

	Flood forecasting and management	1. Flood simulations 2. River routing 3. Contaminant transport (agricultural, domestic, and industrial load) and estimation for ecological management	1. Flood indentation maps 2. River discharge estimates at low-order streams (present and forecasts) 3. Water quality (present and forecast) 4. Report and data
	Water bodies management	1. Dynamic estimation of storage with forecasting 2. Reservoir operations based on dynamic agricultural requirements 3. Water quality monitoring	1. Volume estimates and forecasts 2. Operation schedules/ reservoir release rates 3. Report and data
	Wastewater Treatment	1. Water pollution inventory and corresponding solutions based on a decentralized/centralized system 2. Suitable location and technology required for the entire river stretch	1. Pollutants database 2. Suitable locations 3. Comprehensive plans 4. Maps and data 5. Report
Water Resource Management (Water supply) (WRM)	Demand and Forecasting	1. Current consumption patterns and peak demand assessment based on monitoring data. 2. Future demand projections based on demographic trends and consumption patterns 3. Scenario analysis	1. Demand database 2. Future Predictions 3. Maps and data 4. Report
	Resource Allocation	1. Source sustainability, including Social and economic aspects of water supply 2. Source demarcation for different villages and towns, including future availability 3. Scenario analysis	1. Source Availability 2. Future forecasts 3. Allocation scenarios 4. Report and data
Socio-Hydrological System	Resource management	1. Optimum and sustainable management of water for all stakeholders 2. Identification of sensitive socio-economic factors and leverage points through extensive field study	1. Report containing key stakeholders and their interactions governing the parameters representing Varuna's river rejuvenation

Dynamics (SHSD)		3. Modelling the key parameters and their system dynamics (SD)	
	Impact Assessment	1. Impact assessment of various planned solutions across the system for river rejuvenation 2. Returns feedback/interventions to the hydrological and optimization framework	1. Report with optimum set of hydrological and social interventions

Methodology

Integration for Decision Support System (DSS) development involves front and back-end integration. The front end is the user interface that facilitates user interaction with the system using web technologies like HTML5, CSS, and JavaScript. It includes tools for data input, visualization (e.g., GIS maps, charts), and scenario analysis. Real-time monitoring, interactive dashboards, and alerts enhance decision-making capabilities. Analytical tools optimize management strategies. Reports, notifications, and collaboration features support informed and coordinated actions among stakeholders. Back-end Integrates all modules into a unified system using cloud-based platforms like AWS or Azure. Develop APIs for seamless communication between different modules and databases. Implement data pipelines for real-time data processing and updating.

Further, integration testing is conducted thoroughly to ensure the reliability and accuracy of the DSS, verifying the interoperability of different components. This process addresses any issues or bugs identified during testing and optimizes performance. The DSS is deployed on scalable cloud infrastructure for deployment and maintenance, enabling it to handle varying workloads depending on database size and daily user visits.

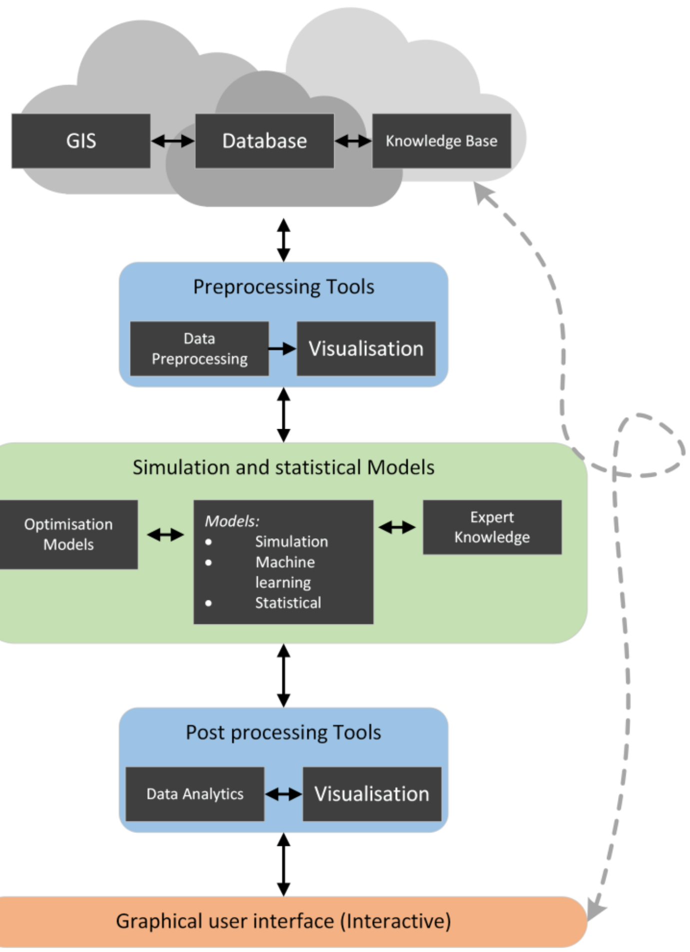

Figure 1. DSS framework

Objective -1: Development of a Data Management Framework

The data management framework is the backbone of a decision support system (DSS), which collects, stores, and manages data from various sources. This framework integrates data from internal databases, external sources, and real-time sensors, ensuring accurate and up-to-date information. It handles data preprocessing tasks such as cleaning, normalization, and transformation and preparing the data for analysis. This framework ensures data security and privacy, implementing data access and storage protocols. The efficient data management enables other DSS modules to perform their functions effectively, providing a solid foundation for informed decision-making.

Data analytics framework

The data is the main driver of any DSS system, and it should be handled properly. The SRMT will integrate different data streams such as IoT-based real-time data, point data collations (River gauge, discharge, groundwater heads, water quality), and remotely sensed data products. The data analytics framework will apply the data preprocessing and analysis in real-time. The data storage will be managed by servers at the SLCR and regularly monitored for optimum operation.

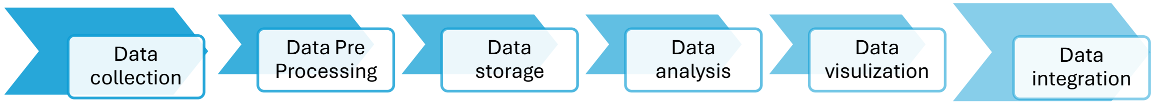

Figure 2. Data analytics framework of SRMT

Data Collection: Collect hydrological data from river gauges, weather data from weather stations, groundwater levels and quality from monitoring wells, water quality data from lab tests, and remotely sensed data from the Distributed Active Archive Centre (DAAC).

Data Processing: Clean, process and integrate data from various sources, ensuring consistency and completeness.

Data Storage: Store processed data in cloud-based data servers, enabling easy access for analysis and model integration.

Data Analysis: Perform Exploratory Data Analysis (EDA) to understand seasonal water availability, use predictive analytics to forecast water demand and supply under different climate scenarios, and apply prescriptive analytics to recommend optimal water allocation strategies. General GIS data such are river morphometry, river encroachment and land use is generated based on automated approach (convolution neural networks or other deep learning models).

Data Visualization: Create interactive dashboards showing real-time water levels, usage, and quality metrics, and use GIS tools to map water resource distributions.

Data Integration: Define the process of data- assimilation to the existing hydrogeological models for informed decision making and process simulations.

Objective -2: Development of Integrated Hydro-Computational Modeling

Integrated Hydro-Computational Modeling framework is the analytical engine of the DSS, hosting various mathematical, statistical, and simulation models that process data to generate insights. This module allows users to apply different models to their data, such as predictive analytics, optimization algorithms, and scenario simulations. It supports creating, modifying, and testing models to ensure they are relevant and accurate for the specific decision-making context. By providing a range of analytical tools and techniques, this framework helps users understand complex relationships within the data, forecast future trends, and evaluate the potential outcomes of different decisions. The major modeling frameworks are discussed in the subsections below.

1.1 Hydrological modelling framework

In contrast to other parts of the DSS, the modeling framework is not an IT development process but rather a modeling exercise carried out by water resources modelers. The model development process consists of setting up the specific simulation models representing the river models. This consists of several tasks, as illustrated in Figure 3. The modeling can be done in any open source or state-of-the-art software (Such as MIKE SHE, SWAT-MODFLOW, HEC-RAS, etc.).

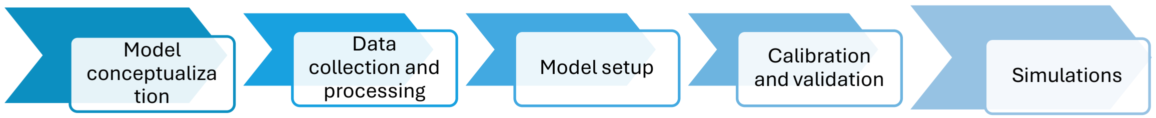

Figure 3: Workflow of developing the modelling framework development of the DSS

The above workflow (shown in Figure 3) is based on an understanding and definition of planning and management issues (needs) in the basins, which must be addressed by the DSS. The model framework must be able to provide the required data and information to be post-processed into useful planning information, e.g., by defined indicator values.

Model conceptualization: Defining the conceptual model setup describing how the basin and the hydrogeological and water resources processes are presented in the model. The initial assessment of the hydrological and Groundwater processes that take place in the given basin is required. The model is conceptualized with boundary conditions and initial source-sink information. This will also define what data is required to represent the basin processes.

Data collection and processing: Assembling all required data and feed these into the model code to construct numerical model. The required data concerns a long array of input data (e.g., climate and river flows) and parametric data describing the characteristics of the basins (e.g., topography, river cross-sections, soil and vegetation pattern, land use, demography etc.), 2d and 3d array of data with aquifer properties, infrastructures (including the operational data), agricultural schemes (e.g., fields and crop management) and other important features.

Calibration and Validation: It is the process of tailoring the model parameters to ensure that the model appropriately represents the basin conditions. This is carried out by comparing time series of model simulation output against observed /gauged variables. This applied mainly to river flow and groundwater heads but can also include other variables such as water levels in lakes, reservoirs, plant evapotranspiration, groundwater storage and rivers.

Simulations: It is the process of using the calibrated model to simulate identified scenarios of future conditions. The process also simulates the present hydrodynamic conditions. The simulations results are generally a time series spatial data of groundwater heads, river aquifer exchanges, river discharge, overland flow, Groundwater recharge etc. These time series will subsequently be post-processed to create appropriate indicator estimations.

1.2 Statistical modelling framework

A statistical modelling framework for hydrological data analysis integrated into a Decision Support System (DSS) involves a systematic approach to processing, analyzing, and interpreting data to support water resource management. Incorporating remotely sensed data enhances this framework by providing comprehensive, high-resolution spatial and temporal information.

Figure 4. Statistical modelling framework with remotely sensed and observed data

Data Collection: it starts with acquiring remote sensing data from satellite sensors, such as precipitation, soil moisture, vegetation indices, land surface temperature, and surface water bodies. These datasets are then integrated with simulation outputs and data analytics output to create a comprehensive and cohesive dataset.

Data Preprocessing: Data cleaning is performed to remove noise, fill missing values, and correct inconsistencies in both remote sensing and ground-based data. Data transformation follows, normalizing and scaling data to ensure consistency and converting data formats to facilitate integration into other modules. Data fusion integrates multiple data sources using techniques like interpolation, data assimilation, and spatial analysis.

Data Analysis (EDA): It is crucial to understand the dataset. Descriptive statistics such as mean, median, standard deviation, and range are calculated to understand data distribution. Data visualization techniques, including plots (e.g., histograms, scatter plots, box plots) and maps (e.g., heatmaps, contour maps), are employed to explore spatial and temporal patterns.

Model Development: It involves several analytical and numerical techniques. Time series analysis uses methods like ARIMA, Seasonal Decomposition, and Fourier Analysis to analyze trends, seasonality, and autocorrelation in hydrological data. Spatial analysis employs geostatistical methods such as Kriging, Spatial Autoregression, and Spatial Clustering to analyze spatial patterns and relationships. Regression analysis helps develop models to identify relationships between hydrological variables and predictors, and machine learning techniques like Random Forest, Support Vector Machines, and Neural Networks are utilized for predictive modeling and classification tasks. Multi-Criteria Decision Making (MCDM) processes utilizes GIS based Weighted Overlay Analysis (WOA) to enforce a decision with expert knowledge. The process is widely used for groundwater potential zonation, flood hazard risk mapping, landslide susceptibility etc.

Model Validation: This is critical to ensuring the accuracy and reliability of the models. Validation involves metrics like R-squared, RMSE, and MAE to evaluate model performance. Cross-validation ensures model robustness and generalizability.

Data Visualization and Interpretation: These are essential for communicating results. Interactive dashboards are created to visualize model outputs, trends, and scenario results in real time. Geospatial visualization tools like GIS are used to map model results, such as predicted water levels, flood extents, and drought severity. Detailed reports and summaries are generated to highlight key findings and insights.

1.3 Optimization modelling framework

An optimization modeling framework for decision-making in water resource management integrates surface water (SW) and groundwater (GW) models to evaluate and optimize water allocation, usage, and conservation strategies. This comprehensive framework assists in making informed decisions that balance various competing demands and ensure sustainable water management.

Problem Definition and Objectives: In this step, the management goals, such as maximizing water supply reliability, minimizing costs, improving water quality, and ensuring environmental sustainability, are defined. This includes Engaging stakeholders (e.g., water managers, policymakers, and community members) to understand their needs and incorporate their inputs into the decision-making process.

Data Collection and Preprocessing: Data is collected from the database and preprocessed for models.

Model Selection and Setup: This step involves the selection of suitable models based on problem definitions (such as using SWAT for surface water simulation and MODFLOW for groundwater modeling or integrating the two models to simulate interactions).

Scenario Development: The baseline scenario is based on current conditions and historical data. The multiple scenarios consider the management strategies, climate change projections, land use change, and socio-economic developments.

Optimization Modelling: Optimization modeling involves the following steps.

- Define the objective function(s) to be optimized (e.g., maximize water availability, minimize operational costs, optimize water quality).
- Identify constraints such as water availability, legal regulations, environmental flow requirements, and infrastructure capacity.
- Apply optimization techniques such as linear programming, nonlinear programming, genetic algorithms, and multi-objective optimization to identify optimal solutions.
- Conduct sensitivity analysis to assess the impact of variations in key parameters and assumptions on the optimization results.

Results and decision-making: The results of the optimization process are analyzed, and the optimum solution is selected.

Monitoring and Adaptive Management: Establishing a monitoring plan is essential to track the performance of implemented strategies and to collect new data for continuous model updates. Implementing an adaptive management approach allows for adjustments to management strategies based on new data, changing conditions, and stakeholder inputs. It is also crucial to regularly review and update the optimization framework to incorporate advancements in modeling techniques, new data, and evolving management goals.

Objective-3: Development of a System Dynamic Modeling Framework

The project aims to develop a system-thinking framework using the System Dynamics (SD) methodology to aid in the rejuvenation of the Varuna River. The work will focus on field studies and participatory methods to gather stakeholders' data and understand the river system's socio-ecological dynamics.

Field Studies and Data Collection: Conduct extensive field studies to identify relevant stakeholders, including riparian communities, government agencies, NGOs, and businesses. Use participatory methods such as interviews, focus groups, and surveys to collect data from stakeholders. Implement riparian walks to observe ground realities and capture perspectives on the Varuna River's bio-physical, social, economic, ecological, and political aspects. Capture dynamic and historical perspectives of the riparian communities to understand past and present interactions shaping the river system.

Data Analysis and Interpretation: Analyze collected data to generate comprehensive information on how stakeholders' actions affect various parameters of the river and vice versa. Utilize systems-thinking tools such as Causal Loop Diagrams (CLDs) and Stock-Flow Diagrams (SFDs) to represent the interactions and feedback loops within the river system.

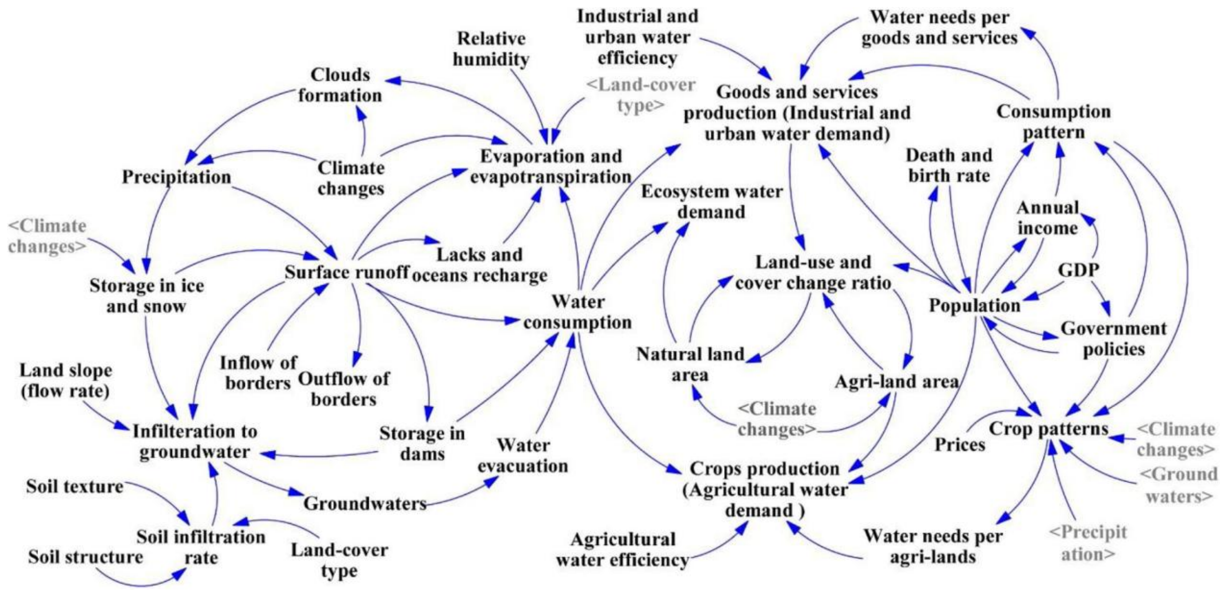

Figure 5. The complexity of the water system dynamic (Source: Barati, A.A. et al., 2019)

Systems-Thinking Framework Development: Develop qualitative models using CLDs to visualize cause-and-effect relationships and feedback loops. Create SFDs to depict the river system's stocks (e.g., water quality, water quantity) and flows (e.g., pollution, water extraction). Potentially, identify leverage points where small changes can lead to significant positive impacts on the river system.

Quantitative Simulation Modeling: Depending on the quality and availability of field data, potentially develop quantitative SD simulation models to simulate various scenarios. Use the simulation models to possibly perform scenario analysis, exploring the impacts of different management strategies and interventions.

Integration with DSS: Use the output from the systems-thinking framework to guide the development of the overall river rejuvenation plan. Facilitate stakeholder engagement by overcoming technical and institutional barriers through the integrated framework. Assess the socio-eco-political feasibility and sustainability of various planned interventions using the system-thinking framework.

Objective-4: Development of a Graphical User Interface Framework

The **Graphical User Interface** (GUI) Module is the interactive component of the DSS, designed to provide users with an intuitive and user-friendly experience. This module includes graphical tools for data visualization, such as charts, graphs, and GIS maps, which help users easily interpret the data and analysis results. It offers forms and dashboards for data input, real-time monitoring, and scenario analysis. The GUI module ensures users can navigate the system seamlessly, access the required functionalities, and receive actionable insights. Effective design and usability of this module are crucial for maximizing the system's utility and ensuring that stakeholders can make informed decisions efficiently.

Knowledge management

The knowledge management framework supports the storage, retrieval, and dissemination of knowledge within the DSS. This module captures best practices, expert insights, and historical data, providing a repository of information that can be leveraged for decision-making. It includes tools for knowledge creation, such as data mining and machine learning, which identify patterns and generate new insights from existing data and scenarios based on the model outputs. The framework also facilitates user knowledge sharing, promoting collaboration and continuous learning. By organizing and managing knowledge effectively, this module enhances the overall intelligence of the DSS, enabling users to make more informed and strategic decisions.

Output by SRMT:

The output of the proposed DSS can be divided into two category 1) Reports and 2) the Data.

Assessment Reports:

The assessment reports from each module (**Table 1**) will be designed in specified formats to use as DPRs or as suggested by client. The reports will explain the results based on maps, data tables and intuitive graphs. The different interventions and scenarios will be compared based on principle factors (such as environmental impact, social impact cost, etc) in forms of graphs and tables, providing a robust decision support to policy makers. Custom reports or Maps can also be generated by minimal inputs.

Data:

The data generated after the post processing (Knowledge/ Information) will be stored in the cloud or backup servers for easy accesses and data security. All the outputs generated will be converted to the generic data formats such as comma separated txt files, Excel sheets, raster dataset

(GeoTiff), and Vectors (shape files). The large outputs will be compressed to NetCDF files and scripts will be provided for easy accesses. These data formats are globally used and supports a wide range of software.

Outcome/Deliverables

The outcome of the proposal will be a well-integrated decision support system specifically designed to enhance the water management for small river basins in India. The modules in the SRMT will cover surface water as well as Groundwater water processes, resulting in an integrated modelling approach. The statistical and optimization modelling framework will utilize state-of-the-art models and genetic algorithms to make optimum decisions as prompted by end user. The major deliverables are as follows:

1. **SRMT**: The integrated tool with GUI.
2. Training and hands-on for the end user.

Timeline

	Year 1				Year 2				Year 3*	
Activity	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**	**Qtr1**	**Qtr2**
Need Assessment										
Model conceptualization										
Database development										
DSS development										
Customization										
Testing										
Application and Demonstration										
Final report										

Teams and Their Responsibilities

Name of Task Leader	Team Members	Responsibilities
Prof Anurag Ohri, Department of Civil Engineering, IIT(BHU)	**Dr. Tanima Dutta,** Department of Computer Sc. and Engg., IIT(BHU) **Dr. Ram Avtar,** Faculty of Environmental Earth Science, Hokkaido University, Japan	Overall Coordination of project, Development and programming of Different modules of DSS, Development of groundwater potential, flood forecasting, resource management submodules
Dr. Pramod Soni, Department of Civil Engineering, IIT(BHU)	**Dr. Shyam Kamal,** Dept of Electrical Engineering, IIT(BHU) **Dr. Medha Jha,** Department of Civil Engineering, IIT(BHU)	Development of Groundwater and surface water models and other input regarding different modules of DSS
Prof. Om Damani, Department of Computer Science, IIT Bombay	**Prof P. K. Mishra,** Department of Chemical Engineering, IIT(BHU) **Dr. Pooja Prasad,** School of Public Policy, IIT Delhi **Dr. Nikhil Bugalia**, Department of Civil Engineering, IIT Madras	Development of a System Dynamic Framework

Terms and Conditions

1. Quarterly progress reports and yearly fund utilization shall be submitted to NMCG.
2. PIs will be called for the presentation in the PRC regarding the project progress.
3. PIs will share their quarterly outcome with the Secretariat of the SLCR.