CHAPTER 3

FRAMEWORK DESIGN FOR SDSS_IUWM

3.1 Introduction

The present study envisages to develop a prototype software as **S**patial **D**ecision **S**upport **S**ystem for **I**ntegrated **U**rban **W**ater **M**anagement, henceforth abbreviated and called **SDSS_IUWM**. The developed software has been designed to work on the Windows operating system.

Urban water management hasvarious component viz. water demand, water supply, wastewater, and storm water. Integration of above components to achieve sustainability is a big challenge.A few previous frameworks related to urban water management are discussed in literature chapter. Further, in order to integrate urban water systems a proposal is presented. Proposal is perceived through a basic framework of Integrated Urban Water Management (IUWM) which is further presented in form of detailed framework of SDSS_IUWM.

3.2 Basic Framework of Integrated Urban Water Management (IUWM)

Data flow diagram of the proposed basic framework (Fig. 3.1) includes details of the water demand, water supply, wastewater generation, reuse and disposal options, wastewater treatment technology selection and storm water management. Water Supply Sustainability (WSS) has been introduced to evaluate Water for Development Planning (WDP). Although before taking any decision for WDP, Factor of Safety (FoS) and Water for Development Planning Index (WDPI) need to be checked which ensures the sustainability criteria i.e. environmental, economic, social and technical.

Initially, the flow diagram includes two components (1) Water Demand (2) Water Supply.

(1) Water Demand (W_D): Water demand is estimated over five categories in urban area i.e. domestic demand based on demography, institutional demand, industrial demand, fire fighting demand and other demand (if any) in city.

(2) Water Supply (W_S): Conventional water supply has two sources i.e. surface water (S_W) and ground water (G_W). In this framework, reclaimed water (R_W) and storm water (ST_W) are considered as alternate water (A_W) supply sources. Reclaimed water is decided on basis of wastewater characteristics, available reuse/disposal options and reuse/disposal standards.

Further, water demand and water supply are the two inputs of Water Demand Adequacy (WDA). Water Supply Sustainability (WSS) is the measure of water which has to be evaluated as an availability of water for new developments in the given urban area. For the above purpose, there is need to check the sustainability criteria (indicators/measures) and Factor of Safety (FoS) which may vary region to region. This will give the WDP for the new developments in the urban area.

Fig. 3.2 shows the logical flow diagram of Alternate Water Supply (AWS). AWS can support supply side directly or indirectly. There are two major components of AWS, first is reclaimed Water and second is Usable Storm Water. Reclaimed water may be used according to need of water in the city for various purposes. In this study reclaimed water based on level of treatment may be reused for six purposes which are irrigation, industrial supply, gardening & recreational, household supply (Other than drinking water), drinking and firefighting. For finding potential of storm water, annual rainfall runoff can be estimated using annual rainfall, land use/ land cover and runoff coefficient for each class of land use/ land cover area. This storm water may store to natural surface reservoirs or rainwater harvesting structures to ensure ground water enrichment. Details of sub-options, categories, process, and data requirements of each component of AWS have been given in Table 3.1.

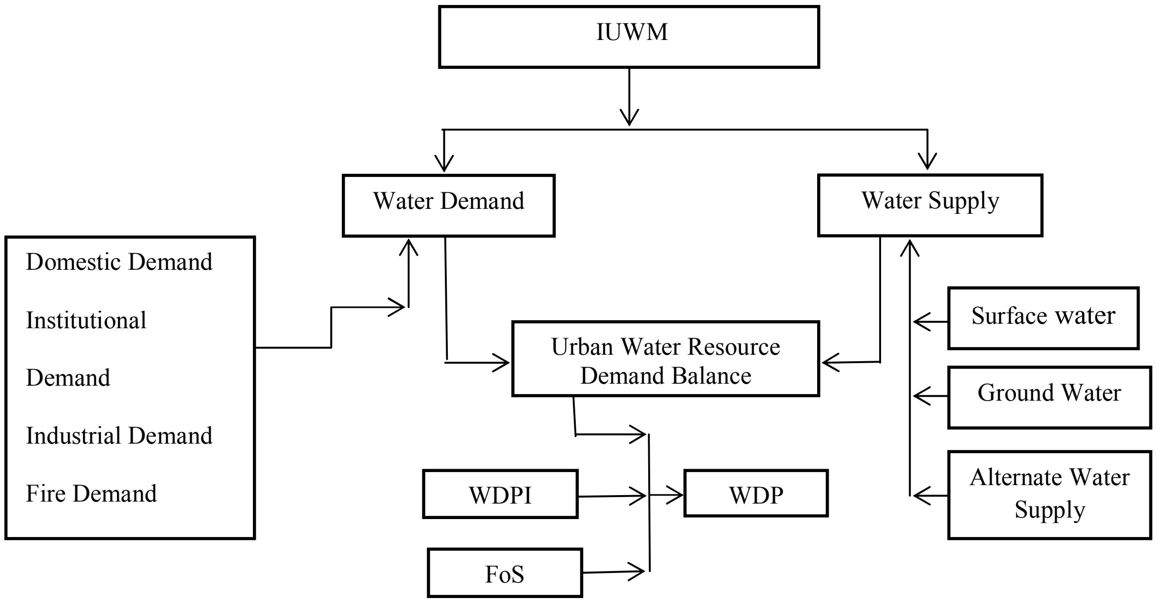

Fig. 3.1: Basic Framework for Integrated Urban Water Management

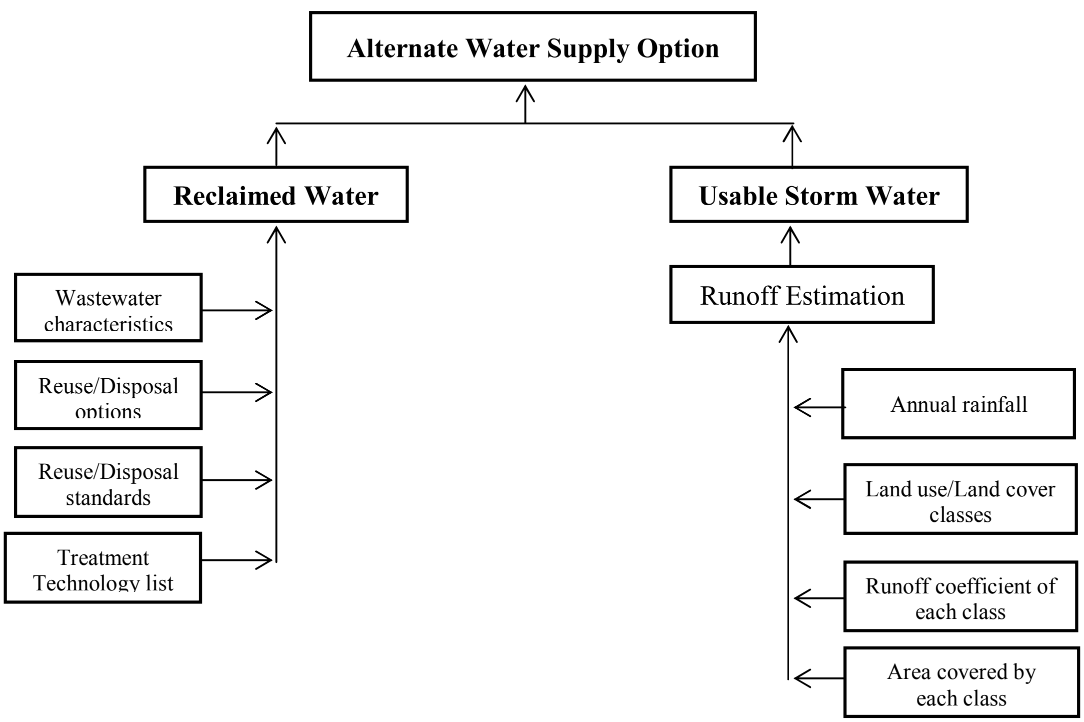

Fig. 3.2: Data Flow Diagram for Alternative Water Supply Options

Table 3.1: Alternative Water Supply (AWS)Option with its Sub-options and Categories

Sr. No.	AWS Options	Sub-Options	Categories	Process/Action	Data Requirement
1.	Reclaimed Water	Reuse	Irrigation Industrial Household Supply(other than drinking) Gardening & Recreational Fire fighting Drinking water	Reuse Option Selection	Standards for each reuse option Wastewater Treatment Technology list (ASP, UASB, SBR, MBBR, TF, WSP) Wastewater characteristics (pH, BOD_5, COD, TDS, TSS, EC, Nitrate, Boron, SAR, Phosphorous, Total Coliform)
		Disposal	Discharge to surface water Artificial groundwater recharge	Disposal Option Selection	Standards for each disposal option Soil Aquifer Treatment (SAT) criteria
2.	Storm Water	Local Water Supply	Surface water augmentation	Runoff Estimation	Annual Rainfall Land use/ Land Cover Classification (built-up, sub-urban, open space, playground and parks, agriculture and forests) Runoff Coefficient for each class Area of each class
		Rainwater harvesting	Groundwater recharge/Enhancement		

3.3 DETAILED FRAMEWORK OF SDSS_IUWM

The framework proposed of spatial decision support for integrated urban water management includes six modules containing different elements of urban water systems. The detailed framework (Fig. 3.3) of SDSS_IUWM consists of six main modules:

1. Water Demand (WD)
2. Water Supply (WS)
3. Wastewater Management (WWM)
4. Storm Water Management (SWM)
5. Water Supply Sustainability (WSS)
6. Water for Development Planning (WDP)

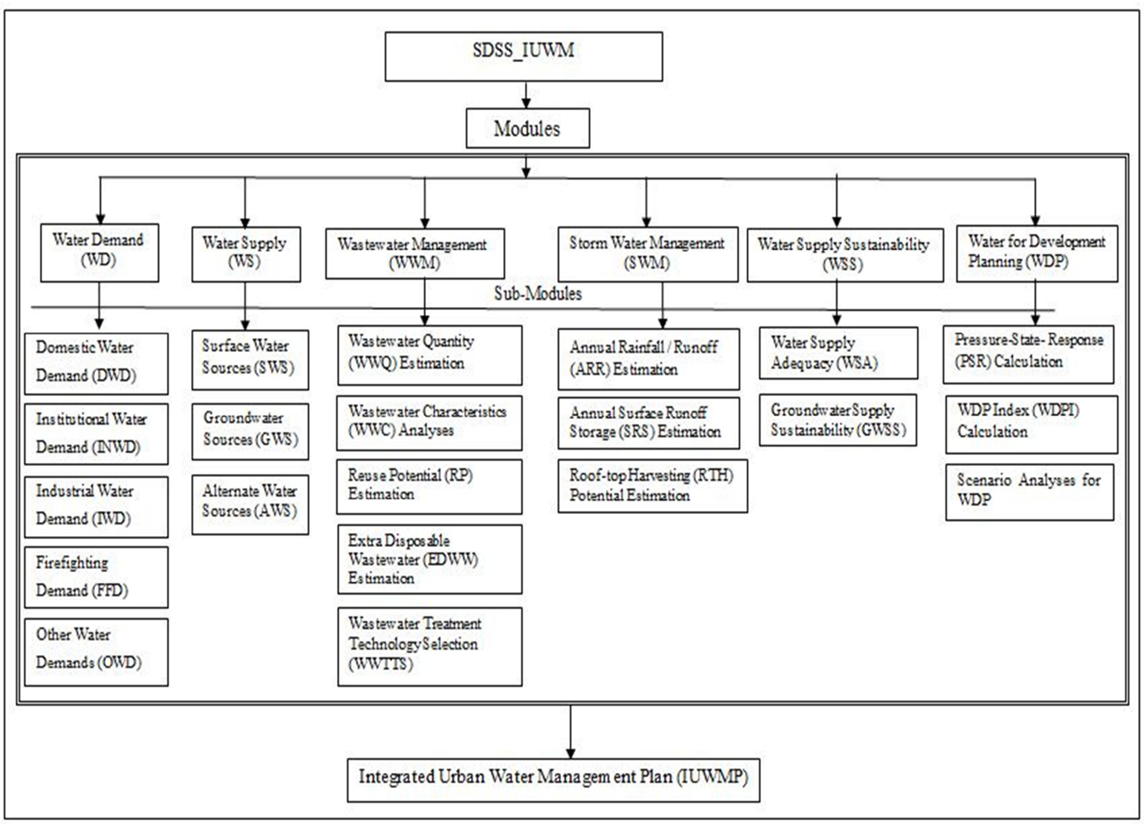

Fig.3.3: Detailed framework of Spatial Decision Support System for Integrated Urban Water Management (SDSS_IUWM).

3.3.1 Water Demand (WD):

Water demand module is an exercise to estimate the different demand of an urban area. Water demands considered in five categories i.e. Domestic Water Demand (DWD), Institutional Water Demand (INWD), Industrial Water Demand (IWD), Firefighting Demand (FFD) and Other Water Demand (OWD). The arithmetic summation of different demands is termed as Total Water Demand (TWD). DWD can be estimated using population data and the standard norms of water supply decided by government authority. INWD can be estimated using various institution details and their daily water demand as per government norms, a population equivalent may be calculated which helps to estimate the actual population served. IWD calculation is based on existing industry types and their water requirement.

3.3.2 Water Supply (WS):

The Water Supply (WS) module estimates quantity of water available through Surface Water Sources (SWS), Ground Water Sources (GWS) and Alternate Water Source (AWS). Treated domestic wastewater (reclaimed water) and rainwater harvesting have been considered as Alternate Water Source (AWS) for non-drinking purpose.

3.3.3 Wastewater Management (WWM):

Waste Water Management (WWM) module has five sub modules: waste water quantity (WWQ) estimation, wastewater characteristics (WWC) analyses, Estimation of reuse potential (RP) of treated reclaimed water in different zones and extra disposable wastewater (EDWW), and wastewater treatment technology selection (WWTTS) for meeting quality standards for selected reuse.

Several wastewater treatment technologies (WWTT) are in practice with varying degree of contaminants removal efficiencies. A paradigm shift has been suggested in the present work. Choice of sewage treatment plant capacity and technology should be done based on reuse potential of treated waste water in different zones and quality standards required for that reuse. Hence, an algorithm has been developed that suggests the options of technologies suitable for particular reuse and/or similar type of reuse in a given zone. Based on reuse potential of the urban area, wastewater treatment technology selection (WWTTS) may be done. This module has functionality to select efficient treatment technology selection based on urban reuse potential and treatment capacity. Seven best practiced technologies in India for wastewater treatment namely Waste Stabilization Pond (WSP), Trickling Filter (TF), Upflow Anaerobic Sludge Blanket (UASB), Activated Sludge Process (ASP), Moving Bed Biofilm Reactor (MBBR)and Sequence Batch Reactor (SBR) are added in the module. Their different costs viz. capital cost, land requirement, operation and maintenance (including annual energy cost, chemical cost, repair cost and manpower cost) and observed removal efficiency to required physico-chemical parameters have been considered for technology comparison. Several traditional reuse options viz. drinking, irrigation, industrial, firefighting, household supply other than drinking, gardening and recreational has been considered.Considering criteria and different standards simultaneously, selection of appropriate wastewater treatment technology can be made.

3.3.4 Storm Water Management (SWM):

Storm water management includes the quantitative estimation of rainfall runoff, surface water storage, roof-top harvesting (RTH) through rain tanks and groundwater recharge. For runoff estimation six classes of land use/land cover have been identified i.e. built-up, sub-urban, open space, parks & playgrounds, agriculture, and forest with their respective runoff coefficients and annual rainfall. Roof-top area is classified in three categories viz. less than 300 to 500 sqm, 500 to 1000sqm and greater than 1000 sqm.

Area of constructed ponds and natural ponds, calculated through satellite imageries are used for calculations of surface runoff storage (SRS).

3.3.5 Water Supply Sustainability (WSS):

Water supply sustainability module has been proposed to estimate the water supply adequacy (WSA) and ground water supply sustainability (GWSS). Water table change over a time period will indicate the sustainability of groundwater supply sustainability within the urban boundary. The arithmetic summation of water supply and demand will give the water supply adequacy of the city. On the basis of resource availability and annual consumption improvement options for WSS can be deduce to improve the water resource management. Different scenario from the above improvement options may be generated and evaluated to improve annual water resource demand balance with the existing system of water demand supply.

3.3.6 Water for Development Planning (WDP):

Water for development planning module consists of two sub-modules i.e. Water for Development Planning Index (WDPI) and estimation of WDP.Estimation of WDP is based on arithmetic difference of water supply and water demand. Before WDP evaluation there is need to check WDPI of the given city. WDPI is based on seven indicators including twenty-two sub-indicators which are arranged in pressure-state-response framework (detailed discussed in chapter 4). If WDPI satisfies the minimum benchmark of qualification then WDP may be allowed to estimate.

Models and methods for the development of each module and sub-modules have given in chapter 5 in detail.