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NATIONAL WATER MISSION (INDIA) TEMPLATES REVISITED

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ABSTRACT

The demand for water is increasing substantially day by day due to increasing population, growing urbanization and rapid industrialization along with the need for raising agricultural productivity. On the other side, the supply of water is either constant or decreasing due to global warming. Therefore, there is an urgent need to utilize the valuable (fresh) water resources efficient and judiciously, and more and more water saving techniques be used to save water for future. For this purpose, the concept of State water budgeting is propagated by the National Water Mission (NWM) of Government of India as an efficient tool, primarily to find out whether the State is water surplus or water deficit. Such a budgeting requires preparation of plans for each of the components of supply, demand and quality. For this, NWM provided a model template for collection of data for each State of the country under State Specific Action Plan (SSAP). The experience in its implementation is that the template is too comprehensive and cumbersome to apply in field conveniently, and therefore, need to be simplified. This study revisits these templates for possible simplification.

INTRODUCTION

Water is a very important component for life, environment and economic development. As a resource, it is critical to sustainable development. Each and every sector of the economy is interconnected with water in some or the other way. Due to rapid population growth and industrial development during the past few decades, there is immense pressure on water resources all over the world. The demands of domestic, agriculture, industrial, and others have increased significantly. Increase in pollution of surface and ground waters is another grave problem. Along with the misuse of water resources, the other factor that has affected the change in climate is the increase in population and industrialization.

India is the second populated country in the world. It has about 17.5% of the world population and it lives with only 4% of the global renewable water resources. The per capita water availability is declining continuously (NCIWRD, 1999). It is accompanied by the challenges of widespread scarcity, flood and contamination across the States in the face of accelerated demand for food security, industry, per capita income etc. Inter-State water sharing conflicts are on rise. The rivers, glaciers, springs and water bodies are shrinking and drying. The problems got accentuated with climate change events resulting in erratic spatial and temporal variability in rainfall and other events. Some implications of climate change on water resources can be described as follows (NWM, 2011): a) Glaciers and snowfields in Himalayas have declined; b) Drought like situations have increased due to overall decrease in the number of rainy days over a major part of the country; c) Flood events have increased due to overall increase in rainy-day intensity; d) Groundwater quality is affected in alluvial aquifers due to increased flood and drought events; e) Groundwater recharge has been influenced due to changes in precipitation and evapotranspiration; and Saline intrusion of coastal and island aquifers has increased due to rise in sea levels.

The imbalance in supply and demand of water is increasing incessantly as the supply of water is constant or decreasing due to global warming whereas the demand is growing day by day. Thus, there is an urgent need to utilize the valuable water resource in efficiently and judiciously. For the efficient use of water, State water budgeting is a useful tool. It as such requires preparation of plans for each of the components of supply, demand and quality. Keeping this in view, the National Water Mission of Government of India provided a model template for water budgeting of all States of the country. The aim of NWM is to ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within the States. One of the five NWM goals is to provide comprehensive water data base in public domain and assessment of the impact of climate change on water resource.

NWM has taken an initiative to bridge the critical water governance gap through an institutional mechanism of State Water Budgeting. If we can budget our finance, we should also be able to budget our water. State Water budgeting is a crucial exercise because while water flows across their natural hydrological units whereas States are political/administrative units. Thus, it is an exercise of harmonizing both science and political units by making water budgets first at basin/sub-basin level and then compiling and consolidating for the State as a whole.

Birkle et al. (1998) studied the water balance for the basin in Mexico and its implications for future water consumptions. The maximum water loss was from evapotranspiration, over-exploitation of ground water declined steadily the potentiometric levels, leading to considerable ground subsidence, and finally suggested measures to balance water deficit in the basin. Kebede et al. (2006) studied water balance of Lake Tana and its sensitivity to fluctuations in rainfall, Blue Nile basin, Ethiopia. Climate change variations played a vital role in

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control of lake hydrology compared to human activities or local forces such as deforestation and accompanied change in runoff, and diversion of water for different purposes like irrigation. Abdulla et al. (2009) assessed the Climate Change impact on the Water Balance of a Semi-arid watershed in Jordan Zaqra river watershed. It resulted in decrease in rainfall and runoff, groundwater recharge as well; and increase in temperature. A number of such studies have been carried out such as, for example, Wang et al. (2009)for Chaobai river, Austin et al. (2010)for Murray-Darling Basin, Australia; Jain et al. (2011) for a basin in India;Mango et al. (2011) Mara River basin of Kenya; Uniyal et al. (2015)for Upper Baitarani river basin of India; Sun et al. (2016); Zhangye city, China; Setti et al. (2017) a forest dominated coastal Nagavali river basin in India among many others. For further details, many recent studies for the water balance has been carried out such as, Patidar et al. (2018) for Ganga river basin, Vanderkelen et al. (2018) for Lake Victoria of East Africa and Koukouli et al. (2018) for Olythios River basin in Northern Greece.

In order to carry out State water budgeting to find out whether the State is water deficit or surplus, the State Specific Action Plan (SSAP) for water sector needs to be formulated based on scientific assessment of the supply and demand side of water resources and vulnerability to climate change. It will help identify and prioritize mitigation/ adaptation strategies; climate change projections; Green House Gas (GHG) emissions (sectors/regions) etc. For implementation of SSAP, NWM has devised a model template. This template is however too comprehensive to apply in field conveniently, and therefore, it needs to be simplified. By such an exercise, a State can be identified as water deficit or surplus and an appropriate plan can be developed for utilization of water for water safety, security and sustainability.

Referring to various documents available on the website of NWM and the presentations made by the stakeholders of different States, various issues/concerns regarding the existing SSAP templates can be listed as below:

- Since the establishment of NWM, the status report on SSAP is being prepared by each State in different formats and there exists non-uniformity in data collection, analysis and reporting.
- There is too much information required by comprehensive document of NWM providing a number of templates. The data may not be available in field.
- All the data required may not be available in field, and therefore, requires simplification of templates, particularly for both collection and utilization of data.
- Supply related data are usually available, but the demand related data not available systematically.
- There is a need to carry out basin level water balance studies to assess the availability of water for preparing SSAP for different States.
- Data from demand side not required immediately for water budgeting under farm sector such as soil type, crop-wise area, production and productivity under rainfed and irrigated ecosystems, crop-wise water requirement and water productivity, crop wise irrigation demand and availability at critical crop growth stages, district wise livestock population statistics (1982-2017), airy/poultry farm and bird/meat processing numbers etc.
- Total demand of water for total industrial use is available, but the demand of water industry-wise not available.
- The major weakness in water management is lack of measurements both in supply side and, most importantly, in demand/consumption side.

Thus, there exists a need of simplification of SSAP templates for efficacious field application. It requires an analysis for evaluating the effect of various hydro-meteorological inputs/parameters and their impact on water availability at the end of the year in water budgeting. Apart from this, revisit NWM templates in terms of their priority in water balance and for field use. Thus, the present study has been carried out with the following objectives: (a) evaluate the effect of different hydrological parameters on water balance and identify the parameters of significance for a typical region, (b) suggest templates specific to areas having different land uses based on the sensitivity results of various hydrological and hydro meteorological parameters/variables used in water balance, and (c) study the available templates for their immediate requirements for water balance study.

METHODOLOGY

(a) Water Balance Equation

For a given problem area, say a catchment, in an interval of time Δt, the continuity equation for water in its various phases is written as:

$V_i - V_o = \Delta S$

where V_i = Inflow volume of water into the problem area during the time period, V_o= Outflow volume of water from the problem area during the time period, ΔS= change in the storage of the water volume over and under the given area during the given period.

While realizing that all the terms in a hydrological water budget equation may not be known to the same degree of accuracy, an expression for the water budget of a catchment for a time interval Δt is written as:

Input - Output (including all the losses and consumptive uses) = Change in Storage

Or, Supply – Demand (including all the losses) = Change in Storage

$P - R - G - E - T = \Delta S$

where, P= Precipitation, R= Surface Runoff, G= net groundwater flow out of the catchment, E= Evaporation, T= Transpiration, ΔS= Change in Storage, The storage S consists of three components

$$S = S_s + S_{sm} + S_g$$

where S_s = Surface water storage, S_{sm}= Water in storage as soil moisture, andS_g = Water in storage as groundwater. Thus,

$$\Delta S = \Delta S_s + \Delta S_{sm} + \Delta S_g$$

All the terms have dimensions of volume or depth.

(b) Proposed procedure for template simplification

The procedure of template simplification is based on sensitivity analysis of various inputs/parameters on the crucial annual water budgeting component, i.e. residual storage, for a hypothetical example State. It is largely to determine whether the basin or State is water deficit or water surplus. The available draft template of SSAP comprises of the report including 565 pages, comprising of 10 chapters and hundreds of tables (or templates). It was felt that the present requirement of the country is to carry out the water balance study, and therefore, the templates required immediately for this purpose should be required to be filled up by the data/information. Thus, the whole report can be divided into three volumes, Volume-I, Volume-II and Volume-III.

These volumes of report are required to meet the expected outcomes of SSAP. The different volumes are divided as per the requirement for carrying out the process for implementation of SSAP. Since the draft templates are prepared with a lot of study and research with the involvement of high level water professional and experts from various organizations and hard work for a very long time. One of the main objectives of simplification of the templates is that whatever data are collected, these should be clear and easily grasped. Some templates give clear information required to carry out the water budgeting, some data give brief description about the land use land cover and other basic information regarding a particular State, some templates are the helping tools for decision making process, some are used for economic analysis which can be helpful in preparation of the plans and strategies for water resources development and management. Thus, the simplification process does not require removal of any template but some of the templates are modified according to their requirement. The templates of the current draft report are divided into the three volumes as per requirements and objectives of the work, as follows:

Volume-I: This is a comprehensive document which acts as a manual. This volume is mainly useful to find out the procedures how and from where to collect the data required to carry out the annual State water budgeting, showing whether State is water deficit or water surplus. This volume can also be used as a reference for different websites for the collection of different types of data. This volume comprises of a list of websites which are used as reference for different data according to requirement. Basically, this describes sources of data. It also shows all the procedures for mathematical calculation of water availability. This volume can also be used for showing all calculations required for water balance. Mostly the templates of bench marking of supply and demand sides (chapter-4) can form a part of this volume besides chapters 1, 2, 3,

Volume II: This volume is the main part of the SSAP report. This volume can be further divided into two parts according to the requirement of the data needed for SSAP implementation. It comprises of two phases, Phase-I and Phase-II. Majority of the templates form a part of this volume, except those required for bench marking, a part of Volume I.

Phase I: This phase of volume I consists of all those templates which are required for carrying out water budgeting for the State. This phase gives the details of all data used directly for water budgeting. All data available for water availability, water utilizable, water demand, water supply, consumptive use and outflow can be a part of this phase. In short, this phase of Volume II of the report comprises of the data required immediately for water budgeting. It is the most important part of the report to carry out State water budgeting and to find out whether the State is water deficit or water surplus.

Phase II: This part of the report comprises of all templates providing the information related to the condition of State, such as, performance indicators, water quality, water economics, etc. The data of this phase shall help the policy makes and water resource manager in preparation of water management planning and strategies. Along with the templates from supply side and demand side, the whole Chapter 7 of the Draft template report which deals with the water financing and economics can be a part of this volume of report. Economic analysis is an important part in water resource management, and thus, is useful in determining the value of water in its various uses. It helps in decision making while making any investment.

Volume III: This volume of the report deals with decisions to be made by policy makers and water managers based on the study carried out and the results of the information of the reports of Volume I and Volume II. Policy makers and water managers should be well aware of all decision making aspects of water resource management plans and policies. This volume of report should provide an assessment of the project status and can include Chapter-5 on Water Sustainable & Efficient technologies and best practices, Chapter-6 on Water Resources: Governance and Management, and Chapter-8 on Outcome of Current governance of Water Resources Issues.

APPLICATION

(a) Study Area

An illustrative (hypothetical) example study area (Fig. 1) as provided by NWM has been selected from the website of nwm.gov.in for this work. In Fig. 1, the whole area bounded by blue rectangle is divided into two sub-basins, Basin A and Basin B and these are divided by watershed divide or ridge. In this region, the yellow dotted line in the shape of pentagon shows the (hypothetical) State boundary. Thus, this example belongs to a hypothetical State/region having two areas named as Area A and Area B adjoining each other and divided by watershed divide. This State is further divided into three types of land use/land cover types, viz., forest, agriculture, and urban type. The details of the study area are given in Fig. 1.

(b) Summary of Data Availability

• Assume, Area A1 from Point A to Point C (60000 Ha) is basically forest area which is nearly 60% of Area A and Area A2 from Point C to Point B (40000 Ha) is agricultural land which is nearly 40% of the Area A
• Reservoir B elevation as on 1st of June = 224M i.e. 110MCM Live Storage (as per EAC Table below)
• Average GW Level in Area A1 as on 1st of June is 4.5 M below GL and equivalent GW Storage (dynamic) = 150 MCM say.
• Average GW Level in Area A2 as on 1st of June is 5.0 M below GL and equivalent GW Storage (dynamic) = 100 MCM say.
• Dynamic GW Storage Capacity is say 1000 MCM (at 1.5 M below GL) so that there is no Water Logging
• Depth of Soil in Area A1 and A2 = 2.0m: Field Capacity = 10% in area A1 and 15% in Area A2

Area A (A1 + A2)		100000	Hectares (Ha)
Area B		50000	Hectares (Ha)
Average Uniform Rain in Area A	Annually	1000	Mm
Average Uniform Rain in Area B	Annually	0	Mm
Total Rain in Area A	Annually	**1000**	**MCM**
Total Rain in Area B	Annually	**0**	**MCM**

Table 1: Elevation Capacity of Reservoir B

Elevation	**Capacity**	**Dead Storage**	**Live Storage**
	MCM	**MCM**	**MCM**
220 (DSL)	110	110	0
221	125		15
222	145		35
223	175		65
224	220		110
225	290		180
226	370		260
227	470		360
228	600		490
229 (FRL)	750		640

RESULTS AND DISCUSSION

(a) Sensitivity Analysis

The sensitivity analysis of different hydrological parameters/inputs is carried out by changing the parameter/input values from the originally assigned values.

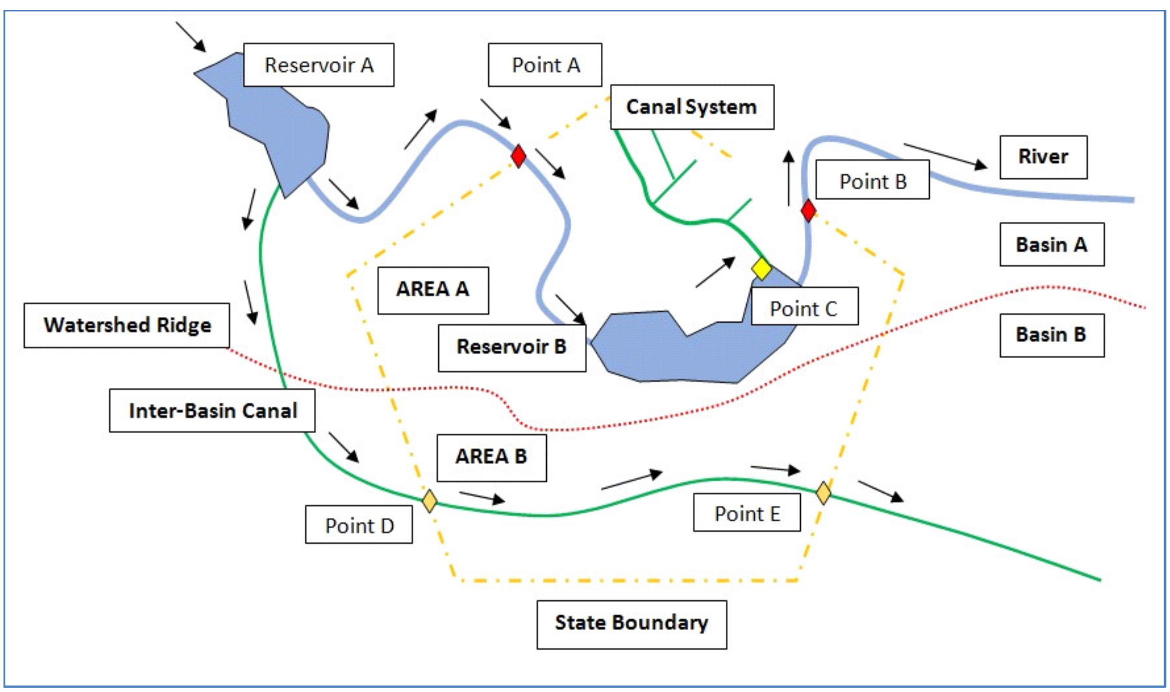


Fig. 1: Illustrative Example of Basin-wise Annual Water Budgeting for a hypothetical State.

To this end, residual storage at the end of the year was selected as the resultant output which is of consideration and importance as this is the carryover water which shall be available for the next year after meeting all demands of State. Higher the residual storage, more water shall be available for the State/basin for meeting different demands next year. Besides, it also indicates that the year of concern has been the wet year during which water was available in excess to meet all the demands of the basin. The greater impact of hydrological variable on residual storage thus indicates greater importance of the parameter, and vice versa. In brief, the sensitivity analysis enhances the importance of the hydrological parameters on the residual storage at the end of the water year.

Sensitivity analysis was performed for the annual water budgeting for a (hypothetical) State. There are different parameters which affect annual water budgeting. The main objective of the sensitivity analysis was to evaluate the effects of uncertainties of different hydrological parameters on the residual storage of the water ground water, soil moisture storage and surface water depending up on the land use/land cover of the area. It shows which is the most sensitive and the least sensitive parameters among all the hydrological parameters. It helps identify and rank parameters that have a significant influence on the change in residual storage for a particular basin.

In this case, the annual water budgeting is carried out for an example (hypothetical) State considering the water year i.e. from 1st of June to 31st May. After calculating the annual water balance in State, the sensitivity analysis is carried out by increasing and decreasing the hydrological parameters by 10% and 20% separately for each of forest, agricultural and urban areas and an assessment is made as how these parameters affect the residual storage.

For Area A1 (Forest Area): Table 2 shows the effect of different hydro-meteorological parameters on the residual storage (= sum of soil moisture storage, ground water and surface water) in a water year in the forest area A1. The parameters/inputs identified for this area are given in Table 2.

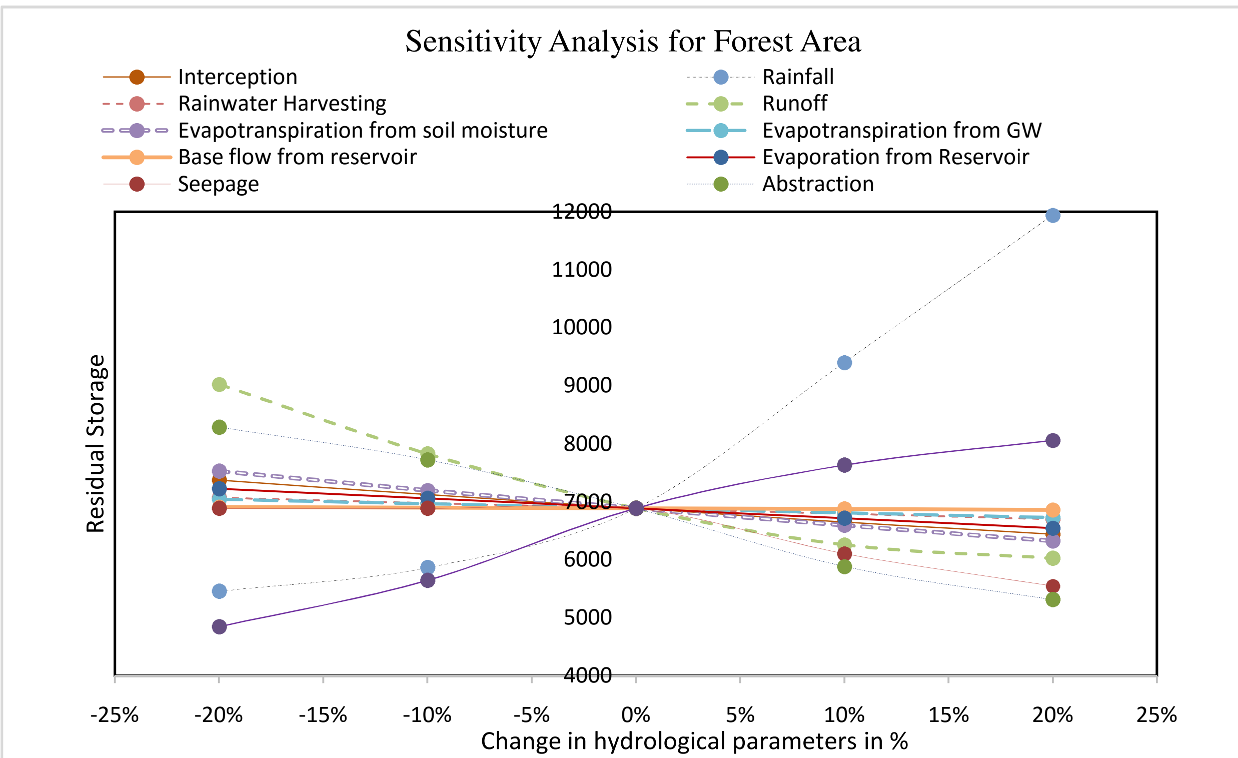
From fig 2 and table 3 it can be seen that the hydrological parameters in the supply side like rainfall and inflow contribute to the residual storage at the end of the year in the forest area. The change in rainfall plays a vital role in the residual storage at the end of the year. From table 3 it can be seen that the increase in the rainfall by 10% and 20% increases the residual storage by 37% and 73 % respectively and the decrease in the rainfall results the residual storage decrease by 15% and 21% respectively. Similarly, the all the other hydrological factors come under the demand side like interception, rainwater harvesting, runoff, evapotranspiration from soil moisture, evapotranspiration from ground water, base flow, evaporation from reservoir, seepage and abstraction. These are the losses in the residual storage of the forest area. Runoff also plays an important role in the residual storage of the area. The calculations show that the losses such as runoff, abstraction, interception and evapotranspiration from the soil moisture resulted in decrease of the residual storage when increased by 10% and 20%, and vice versa. The sensitivity analysis showed that the parameters like rainfall, inflow, runoff had significant effects on the residual storage of the water. The parameters like evaporation from the reservoir, base flow, evapotranspiration from ground water have negligible influence on the residual storage of water. The most sensitive hydrological parameter for a forest area is rainfall

Table 1: Hydro meteorological Parameters for Forest Area A1

S.N.	Parameter	Base Value
1	Precipitation	60% of total rainfall i.e. 600MCM
2	Interception	10% of the rainfall i.e. 60MCM
3	Rainwater Harvesting	5 MCM for June to October
4	Runoff	50% of the rainfall i.e. 300MCM
5	Evapotranspiration from Soil Moisture	10 MCM for all months
6	Evapotranspiration from Ground water	10 MCM for all months
7	Baseflow	10% of the ground water storage
8	Evaporation from reservoir	5% of the initial surface water storage
9	Seepage from reservoir	0 MCM
10	Abstraction from reservoir	Different values assumed i.e. 100MCM for June, 150MCM for July, 250MCM for August, 150MCM for September, 100MCM for October and November, 150MCM for December and January, 200MCM for February, 100MCM for March and 0MCM for April and May
11	Inflow at point A	Different values assumed i.e. 200MCM for June, 300MCM for July, 350MCM for August, 250MCM for September, 100MCM for October, 50MCM for November, December, January, February, March, April and May respectively.

Table 2: Change in the residual storage in forest area A1

Parameter Variable	Absolute change in residual storage					Percent change in residual storage					Gradient	Sensitivity ranking	Remarks
	Percent Change					Percent Change							
	-0%	-0%	0%	10%	20%	-0%	-0%	0%	10%	20%			
Interception	7371	7123	6884	6651	6441	7	3	0	-3	-6	23.2	VII	
Rainfall	5453	5864	6884	9400	11941	-21	-15	0	37	73	162.2	I	Most
Rainwater Harvesting	7068	6976	6884	6792	6700	3	1	0	-1	-3	9.2	IX	
Runoff	9025	7822	6884	6258	6023	31	14	0	-9	-13	75.1	III	
ET from soil moisture	7525	7196	6884	6594	6323	9	5	0	-4	-8	30.1	VI	
ET from ground water	7040	6962	6884	6806	6728	2	1	0	-1	-2	7.8	X	
Base flow	6908	6896	6884	6872	6860	0	0	0	0	0	1.2	XI	Least
Evaporation from reservoir	7223	7058	6884	6715	6546	5	3	0	-2	-5	16.9	VIII	
Seepage	6884	6884	6884	6104	5546	0	0	0	-11	-19	33.5	V	
Abstraction	8283	7721	6884	5882	5311	20	12	0	-15	-23	74.3	IV	
Inflow	4841	5642	6884	7631	8059	-30	-18	0	11	17	80.4	II	



and runoff and the least sensitive parameter is base flow and other less sensitive parameter are evapotranspiration from reservoir, rainwater harvesting and evapotranspiration from groundwater.

For Area A2 (Agricultural Area): Table 4 shows the effect of different hydro meteorological parameters on the residual storage (= soil moisture storage and ground water) in a water year in the agricultural area A2. In the area A2 surface water is not considered. The parameters/inputs identified for this area are as follows:

Table 3: Hydrological Parameters For Agriculture Area A2

S.N	Hydrological Parameters	Coefficients of Parameters
1	Precipitation	40% of total rainfall i.e 400MCM
2	Interception	10% of the rainfall i.e. 60MCM
3	Rainwater Harvesting	Assumed to be 10 MCM for the rainfall months i.e from June to October
4	Runoff	It is assumed to be 30% of the rainfall i.e 120MCM
5	Soil Moisture due to irrigation	Considering 80% of the water is used for irrigation in the agriculture field with 50% overall efficiency with values taken as 40MCM for June, 60Mcm for July, 100MCM for August, 60MCM for September, 40MCM for October and November, 60MCM for December and January, 80MCM for February, 40MCM for March and 0MCM for April and May.
6	Evapotranspiration from Soil Moisture	Different values assumed i.e. 50MCM for June, 60MCM for July, 70MCM for August, 80MCM for September, 90MCM for October, 50MCM for November, 60MCM for December, 70MCM for January, 80MCM for February, 600MCM for March and 50MCM for April and May
7	Evapotranspiration from Ground water	It is taken as 0MCM for all the months
8	Return flow and base flow	Return flow is taken as 20% of (Residual Soil Moisture- Field Capacity) and base flow is taken as 10% of initial ground water storage and 80% of the @20% of the total water abstraction.
9	Evaporation loss from canal system	25% of irrigation water supplied
10	Seepage loss from canal system	25% of irrigation water supplied

Table 4: Change in the residual storage in agricultural area A2

Parameter Variable	Absolute change in residual storage					Percent change in residual storage					Gradient	Sensitivity ranking	Remarks
	Percent Change					Percent Change							
	-20%	-10%	0%	10%	20%	-0%	-0%	0%	10%	20%			
Rainfall	2060	2830	4046	6127	8265	-49	-30	0	51	104	155	I	Most
Interception	4453	4250	4046	3876	3705	10	5	0	-4	-8	19	IX	
Rainwater Harvesting	4527	4286	4046	3847	3649	12	6	0	-5	-10	22	VIII	
Runoff	5277	4657	4046	3558	3213	30	15	0	-12	-21	52	VI	
Soil Moisture due to irrigation	2315	3019	4046	5995	8075	-43	-25	0	48	100	144	III	
ET from Soil Moisture	8486	6198	4046	2997	2292	110	53	0	-26	-43	155	II	
ET from Ground water	4046	4046	4046	3266	2490	0	0	0	-19	-38	39	VII	
Return Flow and Baseflow	4416	4231	4046	3861	3676	9	5	0	-5	-9	18	X	Least
Evaporation loss from Canal	5965	4984	4046	3406	3019	47	23	0	-16	-25	74	V	
Seepage loss from canal	2581	3216	4046	5203	6403	-36	-21	0	29	58	96	IV	

From figure 3 and table 5, it can be seen that the hydrological parameters in the supply side like the rainfall contributed significantly to the residual storage at the end of the year in the agricultural area. The change in rainfall pattern plays a vital role in the residual storage at the end of the year. From table 5 it can be seen that the increase in the rainfall by 10% and 20% increases the residual storage by 51% and 104% respectively and the decrease in the rainfall results the residual storage decrease by 30% and 49% respectively. Similarly, all other hydrological factors come under the demand side like interception, rainwater harvesting, runoff, evapotranspiration from soil moisture, evapotranspiration from ground water, return flow and base flow, evaporation from canal and seepage. These are the losses in the residual storage of the agriculture area. Runoff also plays an important role in the residual storage of the area. The calculations show that the losses such as evapotranspiration from soil moisture, runoff, interception, resulted in the decrease of the residual storage when increased by 10% and 20% and vice versa. The sensitivity

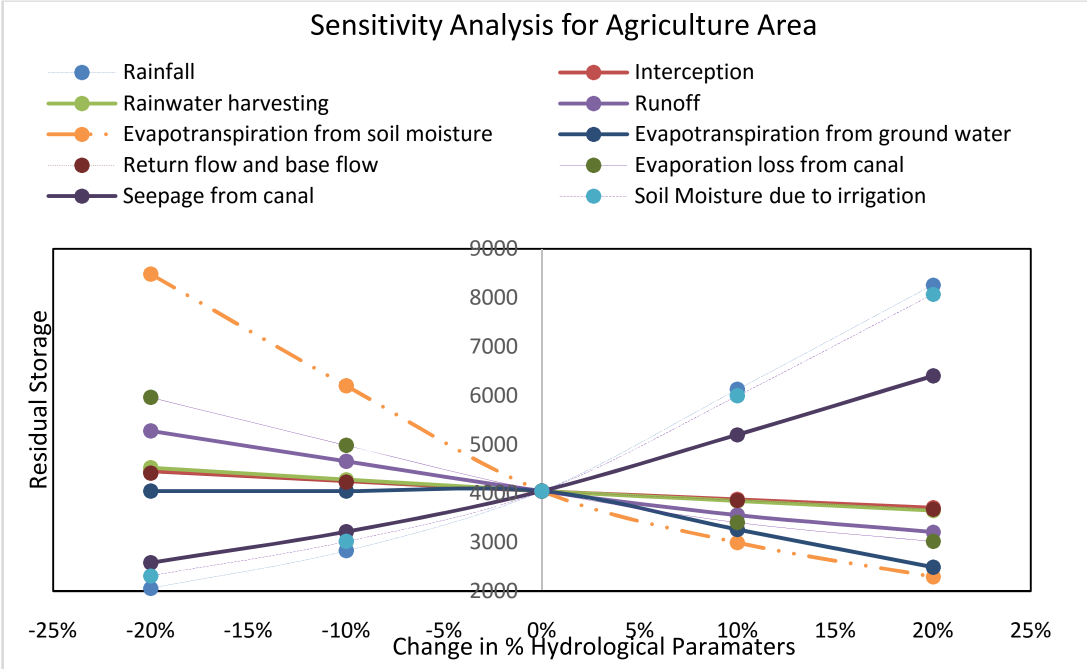


Fig. 2: Sensitivity Analysis for agriculture area

analysis showed that the parameters like rainfall had significant effects on the residual storage of the water. The parameters like Rainwater harvesting, interception and return flow and base flow have negligible influence on the residual storage of water. The most sensitive hydrological parameter for an agricultural area are rainfall and evapotranspiration soil moisture respectively and after that the least sensitive parameter is return flow and base flow and the other less sensitive parameters are rainwater harvesting and interception.

For Area B (Urban Area): For the urban area, there is no surface water and ground water source. As described previously, area B is an urban area and there is an inter basin canal which is carrying water from the basin A to basin B and in this area there is only use of water for the domestic purpose and the industrial purposes. There is no particular sensitivity analysis of hydrologic parameters in this area as it is assumed that there is no rainfall in Area B. So there is no consideration of any of the hydrologic parameters as rainfall, runoff, interception, evapotranspiration etc. In this area three main factors are considered that is the inter basin canal carrying water, withdrawal of water for the consumptive use like for the domestic purposes and industrial purposes and the return flow of water by recycling and reusing the water. Table 7 shows the effect of different parameters on the volume of outflow water from point E in a water year in the urban area B. This table 7shows how the changes in the withdrawal of water, water in inter-basin transfer (IBT) canal and return flow of water after the recycle causes changes in the total outflow of water from basin B. The parameters/inputs identified for this area are shown in table 6 below.

Table 6: Parameters for Urban Area B

S. N	Hydrological Parameters	Coefficients of Parameters
1	Water from IBT Canal	30MCM for all months
2	Withdrawal of water	10MCM for all months
3	Return flow	80% of the withdrawal of water i.e. 8MCM

Table 5: Change in the residual storage in Area B

Parameter Variable	Absolute change in residual storage					Percent change in residual storage					Gradient	Sensitivity Ranking	Remarks
	Percent change					Percent change							
	-20%	-10%	0%	10%	20%	-20%	-10%	0%	10%	20%			
Inter Basin Transfer Canal (Import)	264	300	336	372	408	-21	-11	0	11	21	4	I	Most
Withdrawal for Use	360	348	336	324	312	7	4	0	-4	-7	1	II	
Return Flow	317	326	336	346	355	-6	-3	0	3	6	1	III	Least

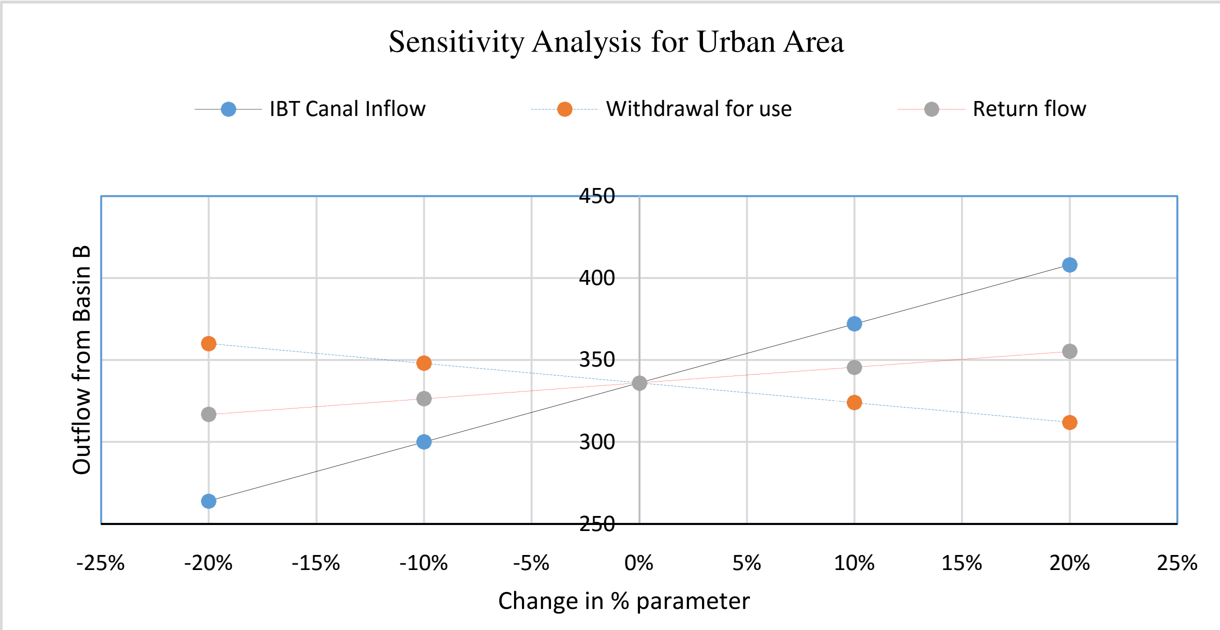


Fig. 3: Sensitivity Analysis for urban area

From figure 4 and table 7, the most sensitive parameter is water carried in the inter-basin transfer canal and the least sensitive one is the return flow of water into the IBT canal.

Simplification of Templates

It has already been discussed before that there is no uniformity among the States regarding the collection of various data required for the templates. The templates for the demand side have already been divided based on land use land cover type. Basically, there are three land use/land cover types, forest, agriculture and urban area. The urban area covers both the demand of water for the industrial and domestic purposes. In case of India, the maximum demand of water comes from agriculture. More than 70% of water demand is for agriculture purpose as this sector is a dominant user of water. The simplification of templates should also be based on which sector contributes most for carrying out the water budgeting of a basin/ State.

The basic premise of simplification is that the whole bulky report of Draft Templates can be primarily divided into three volumes. Volume I should describe basic information of the State along with all the steps, methods and procedures to carry out water budgeting. Volume II should comprise of two phases, Phase I and Phase II. Phase I consists of all the templates which are immediately required to carry out water budgeting and Phase II should consist of the templates of performance indicators, water economics, water productivity, waste water, water quality, water use efficiency etc. Based on the information provided in Volume I and Volume II, Volume III should be brought out and it should include the analysis/recommendation which can be used as a tool for the policy makers and water resource experts for policy/decision making for the water resource management.

The table consists of 12 columns. Different columns relate to chapter number, section, title of the chapter, page number, table number and the different volumes, i.e. Volume I and Volume II. The second volume can be further sub-divided into Phase I and Phase II. Those templates which are directly related with water budgeting are taken in Phase-I and the templates of water productivity, performance indicators, water quality, water intensity, water economics, water use efficiency etc. in Phase –II, as they are not required immediately. If the templates are to be taken as such without any change in the draft template, then it is complete and there are changes in the available Draft template, such as removal or shifting of some rows or columns of the table to Phase II, it is categorized as partial with reasons noted in remarks. The remarks column has been added so that any additional information related to the tables can be written in this part.

CONCLUSIONS

The following conclusions can be derived from the study:

- The immediate need of the country is to carry out the water budgeting, for which draft templates were prepared by National Water Mission but these comprise of 565-page comprehensive report. The templates in the draft report require varied information which may/may not be directly required for carrying out the water budgeting.
- To carry out water budgeting, the templates presented in the draft report of SSAP have been divided into three volumes depending upon the requirement. Volume I comprises of the basic information of the State along with all the steps, methods and procedures to carry out the water budgeting. Volume II comprises of two phases, Phase I and Phase II. Phase I consists of all the templates which are required to carry out the water

budgeting and Phase II consists of the templates of performance indicators, water economics, water productivity, waste water, water quality, water use efficiency etc. Volume III comprises the templates and it acts as tools for the policy makers and water resource experts for policy making for the water resource management.

- The templates of the draft report have been classified into three volumes for creating uniformity in data collection, analysis and reporting.
- Based on the sensitivity analysis performed for a particular State for different land uses to show which parameter has the maximum effect on the residual storage considering the soil moisture storage, ground water and surface water storage at the end of the year, the results showed that the most sensitive parameter for forest area is rainfall and least sensitive parameter is baseflow, for agricultural area the most sensitive parameter is rainfall and the least sensitive parameter is base flow and return flow and finally for urban area, the most sensitive parameter is the water carried in the inter basin transfer canal and the least sensitive parameter is return flow of water.

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